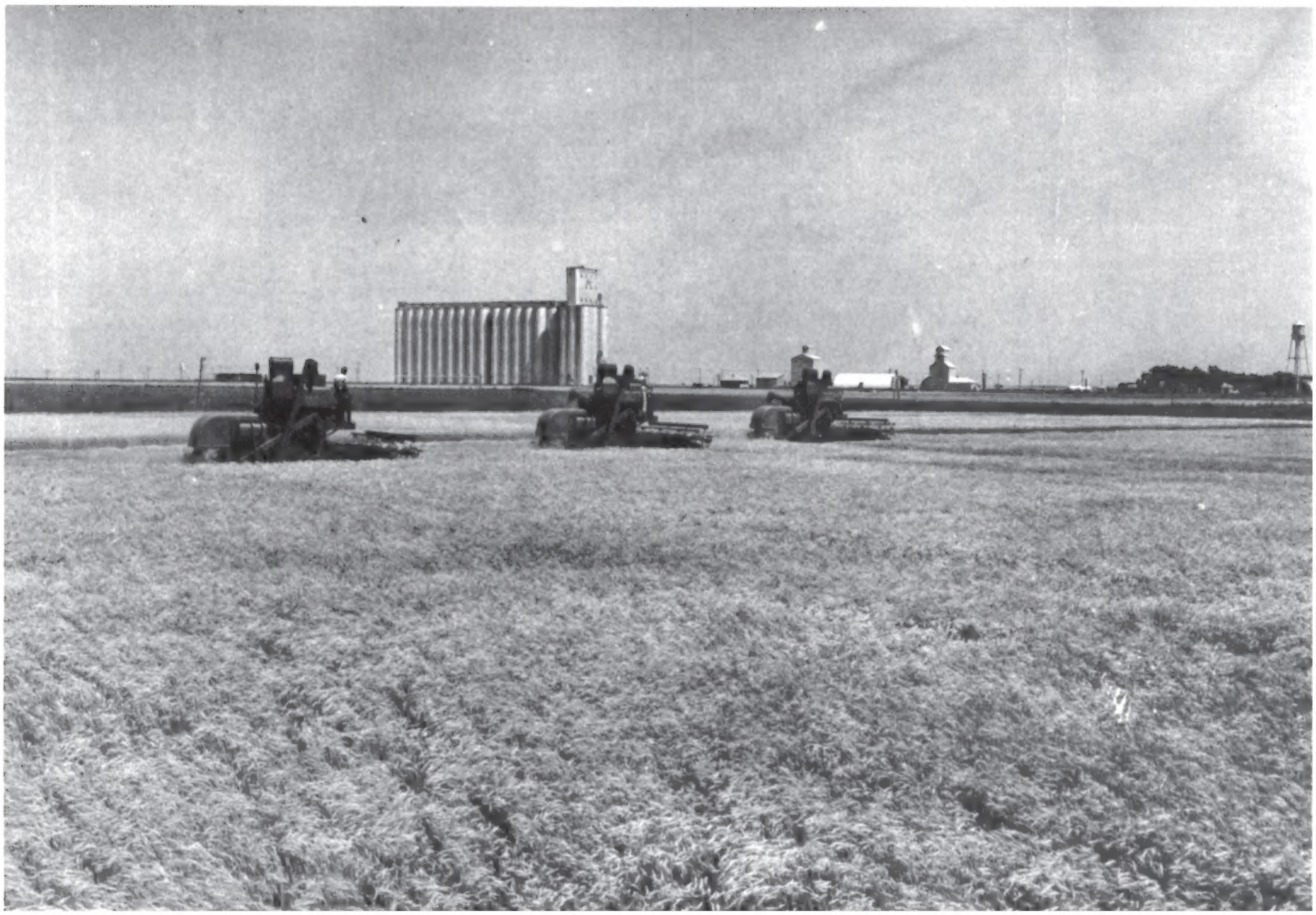
# SOIL SURVEY

# GRAY COUNTY

# Kansas



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
KANSAS AGRICULTURAL EXPERIMENT STATION

Issued January, 1968

Major fieldwork for this soil survey was done in the period 1962–65. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1962. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station; it is part of the technical assistance furnished to the Gray County Soil Conservation District.

# HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Gray County contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

## Locating Soils

All the soils of Gray County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

## Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils in the soil descriptions and in the discussions of capability units and range sites.

*Game managers, sportsmen, and others concerned with wildlife* will find information about soils and wildlife in the section "Wildlife Management."

*Ranchers and others* interested in range can find, under "Range Management," descriptions of range sites, or soils grouped according to their suitability for range. Plants that grow on each range site are named.

*Engineers and builders* will find under "Engineering Uses of Soils" tables that give engineering properties of the soils in the county and that name soil features that affect engineering practices and structures.

*Scientists and others* can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

*Students, teachers, and others* will find information about soils and their management in various parts of the text, depending on their particular interest.

*Newcomers in Gray County* may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

**Cover picture.—Harvesting wheat on Harney silt loam.**

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page

Issued January 1968

## EXPLANATION

### Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

# SOIL SURVEY OF GRAY COUNTY, KANSAS

REPORT BY BOB I. TOMASU AND WILLIAM E. ROTH, SOIL CONSERVATION SERVICE[1]

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH KANSAS AGRICULTURAL EXPERIMENT STATION

GRAY COUNTY is on the High Plains in the southwestern part of Kansas (fig. 1). Most of the county consists of nearly level to gently sloping plains. Elevations range from about 2,550 feet above sea level to about 2,900 feet. The county has an approximate area of 869 square miles, or 556,160 acres. It extends about 24 miles from east to west and about 36 miles from north to south.

Gray County has abundant sunshine and low annual rainfall. The daily temperature varies widely. The length of the growing season ranges from about 170 to 180 days.

The primary income in the county is from the sale of farm products. Wheat and grain sorghum are the principal cash crops grown; the principal kind of livestock is beef cattle.

## *How This Survey Was Made*

Soil scientists made this survey to learn what kinds of soils are in Gray County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

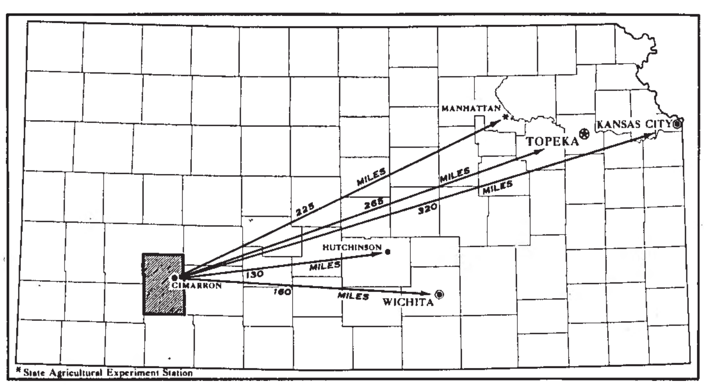


***Figure 1.*—Location of Gray County in Kansas.**

[1] Others participating in the field survey were JOHN B. BAUMANN and ROGER L. HABERMAN, Soil Conservation Service.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. For successful use of this survey, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Richfield and Spearville, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape. Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Tivoli loamy fine sand and Tivoli fine sand are two soil types in the Tivoli series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Ulysses silt loam, 3 to 6 percent slopes, is one of several phases of Ulysses silt loam, a soil type that ranges from nearly level to sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that greatly help in drawing soil boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soils in it; for example, Mansker-Potter complex. The soil scientist may also show as one mapping unit two or more soils if the differences between them are so small that they do not justify separation for the purpose of the survey. Such a mapping unit is called an undifferentiated soil group; for example, Las Animas soils. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Gravelly broken land or Blown-out land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are predicted for all soils suitable for crops.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey. On the basis of yield and practice tables and other data, the soil scientists set up trial groups, and then test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

# *General Soil Map*

The general soil map at the back of this survey shows, in color, the soil associations in Gray County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The general soil map of Gray County shows seven soil associations in four general kinds of landscape. Three are in the High Plains; two are in the sandhills and areas nearby; one is along the Arkansas River; and one is in the drainage basin of Crooked Creek.

## 1. Spearville-Richfield Association

*Nearly level, deep, clayey and loamy soils of the High Plains tableland*

This association, the largest in the county, makes up 35 percent of the land area. It is in broad, nearly level areas (fig. 2) in the northwestern corner and the southern half of the county.

The Spearville soils are dominant in most of this association, but large areas of Richfield soils also occur. The Spearville soils are in broad, nearly level areas where drainageways are poorly defined. They have a loamy surface layer and a clayey subsoil.

The Richfield soils occur in convex areas of the nearly level parts of the High Plains. These soils are deep and have a subangular blocky silty clay loam subsoil. They are dominant in the northwestern corner of the county, where they are closely intermingled with Spearville soils, and where slopes are weakly convex and weakly concave.

Also in this association are the Harney soils and the Randall soils. The Harney soils occupy broad, nearly level areas in the east-central part of the county. The Randall soils occur on the floors of depressions throughout the association.

Most of the acreage in this association is used for cash crops of wheat and sorghum. An area near Montezuma makes up the major part of the land irrigated in Gray County. Wind erosion is a hazard in the nearly level areas, and water and wind erosion are hazards on gentle slopes. On all the soils in this association, water conservation is needed for profitable production of crops.

## 2. Spearville-Harney Association

*Nearly level and slightly concave, deep, clayey soils of the High Plains tableland*

This association is in one broad, dominantly nearly level area. It makes up about 21 percent of the county and is in the northeastern part.

The Spearville soils are dominant in this association, but large areas of Harney soils also occur. The Spearville soils are in the broad, nearly level areas where drainageways are poorly defined. These soils have a loamy surface layer and a clayey subsoil.

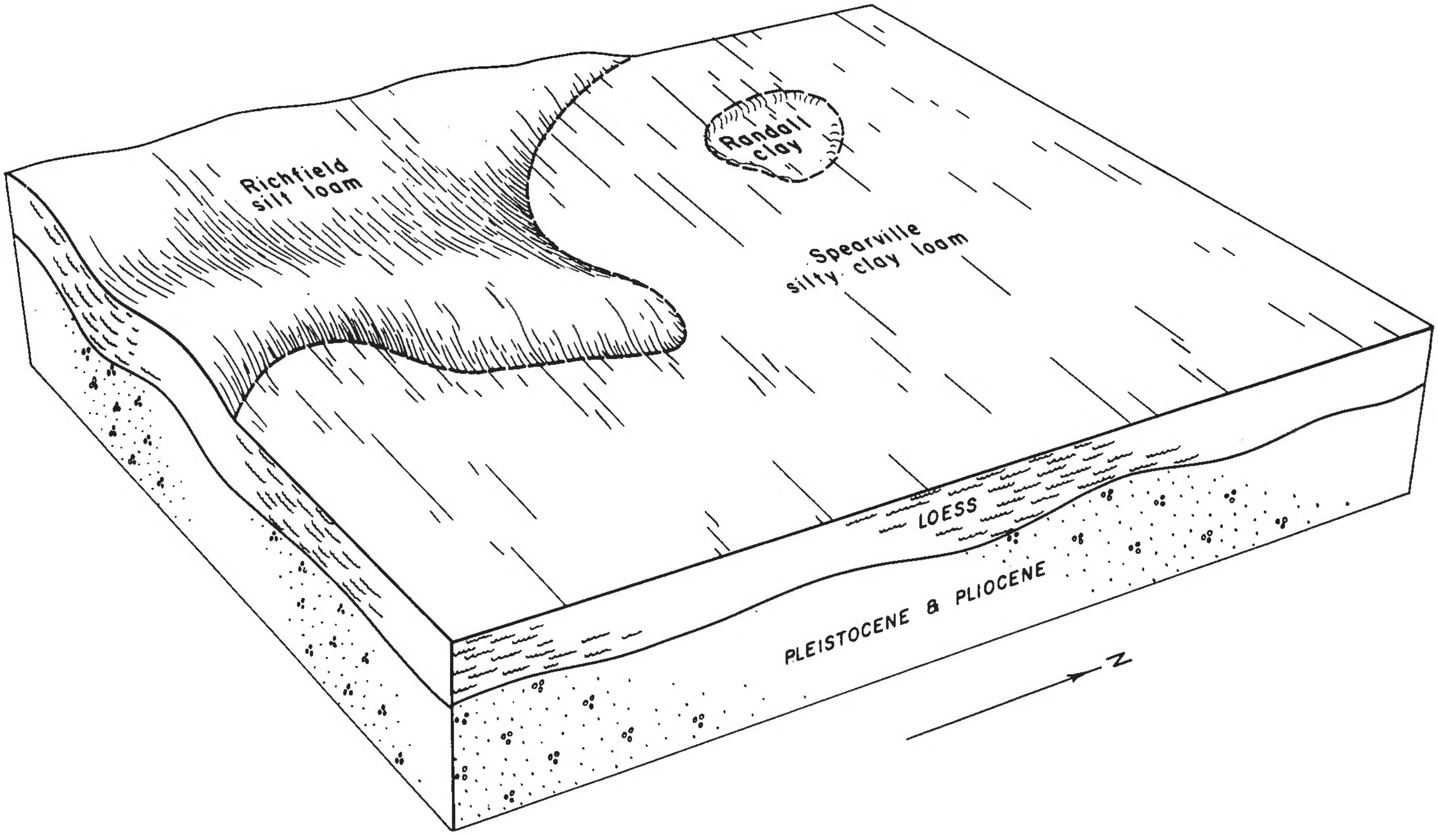


*Figure 2.*—Soils of the Spearville-Richfield soil association.

The Harney soils are in the lower lying, nearly level or slightly concave parts of the High Plains. These are deep soils that have an upper subsoil of subangular blocky silty clay loam and a lower subsoil of blocky silty clay.

Also in this association, on the floor of depressions, are the deep, clayey Randall soils.

Most of this association is used for cash crops of wheat and grain sorghum. Wind erosion is a hazard in nearly level areas, and wind and water erosion are hazards on gentle slopes. On all the soils in this association, water conservation is needed for profitable production of crops.

## 3. Mansic-Ulysses Association

*Sloping to steep, deep, loamy soils of the High Plains*

Most of this association lies along the northern side of the Arkansas River. A smaller tract is in the northeastern part of the county. This association is dominantly sloping to steep (fig. 3); it makes up about 3 percent of the county.

The Mansic soils are dominant in this association, but large areas of Ulysses soils also occur. The Mansic soils occupy the sloping and moderately steep side slopes along drainageways that empty into the Arkansas River. These soils have a clay loam surface layer and subsoil.

The Ulysses soils occupy only the gentle slopes and the small, nearly level areas. These are silty soils in which the surface soil is not distinctly different from the subsoil.

Also in this association are minor areas of Gravelly broken land and of closely intermingled Mansker and Potter soils. Gravelly broken land occupies steep and broken slopes in the western part of this association. It is shallow to moderately deep over gravel. The closely intermingled Mansker and Potter soils make up a small, but important, part of the association. The Mansker soils are moderately deep over well-defined layers of accumulated lime. The Potter soils are shallow over caliche or limestone.

Most of this association remains in native grasses and is used for grazing. The gently sloping soils and some of the sloping soils are cultivated. The main crops are wheat and sorghum. Crop failures are common, and yields are profitable only during years of most favorable weather. Both wind and water erosion are serious hazards in cultivated areas. Conservation of water is needed to obtain favorable yields.

## 4. Las Animas-Leshara-Lesho Association

*Nearly level, deep and shallow, well-drained and somewhat poorly drained loamy soils in the valley of the Arkansas River*

This association consists of the flood plain of the Arkansas River and the alluvial fans along the northern edge of the flood plain. The association is 1 to 1.5 miles wide and makes up about 4 percent of the county. It is bordered on the north by the moderately steep Mansic soils and the steep Gravelly broken land in soil association 3. On the south are the sandhills of soil association 5.

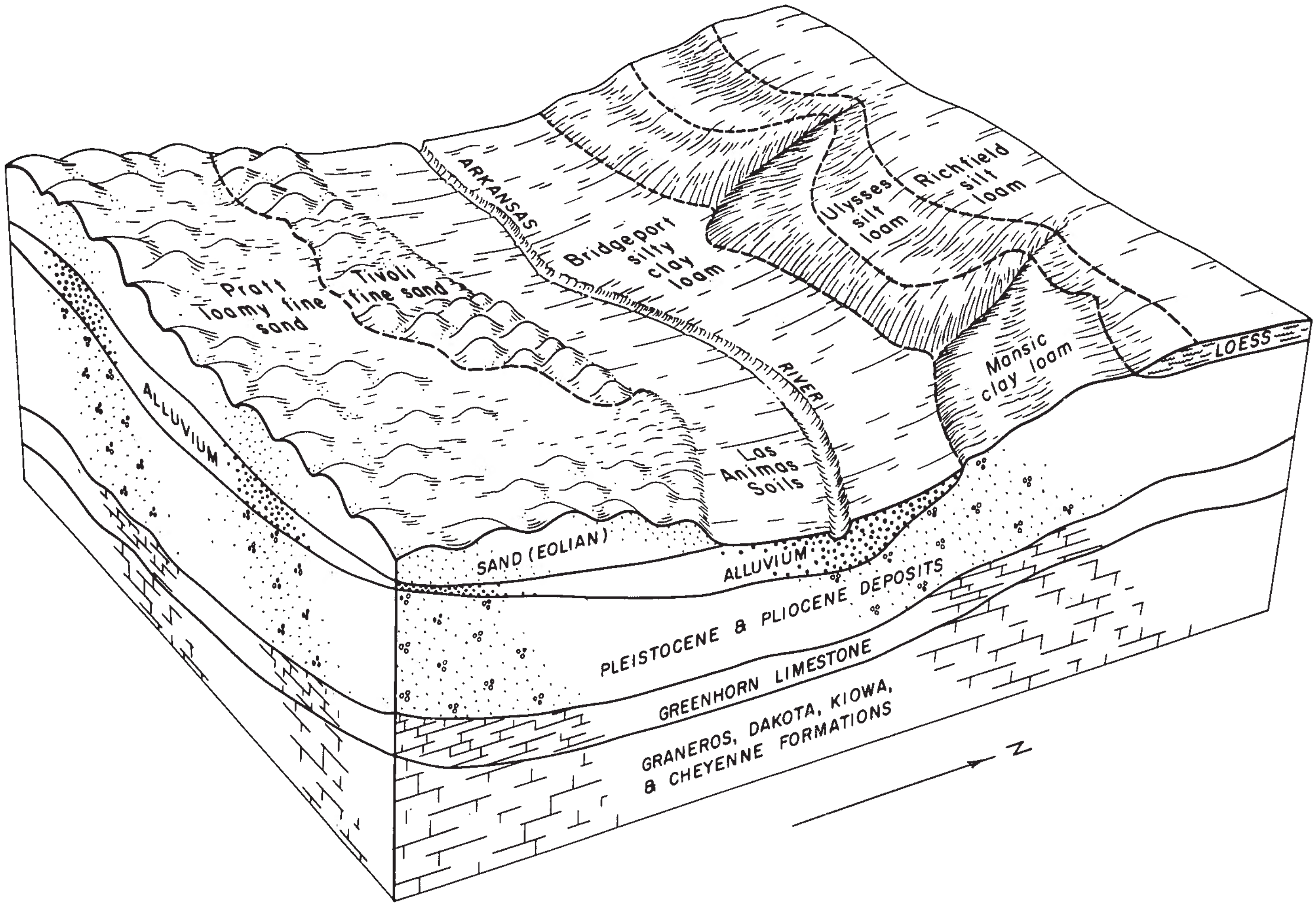


*Figure 3.*—**Soils of the Mansic-Ulysses soil association are on the right; on the left are soils of the Pratt-Tivoli soil association.**

The Las Animas, Leshara, and Lesho soils are on the flood plain throughout the association. These soils have a fluctuating water table, and they are slightly to moderately saline-alkali. The Las Animas soils generally have a fine sandy loam surface layer and subsoil. The Leshara and Lesho soils have a clay loam surface layer and subsoil.

Also in this association are the Lincoln, Sweetwater, and Bridgeport soils. The Lincoln and Sweetwater soils are on the flood plain, the Lincoln lying next to the channel. The Bridgeport soils are on alluvial fans and aprons along the northern side of the flood plain. The Lincoln soils consist of very sandy, recently deposited alluvium. The Sweetwater and Bridgeport soils have a loamy surface layer and subsoil. The water table of the Sweetwater soils is high but fairly stable.

Some areas of the Las Animas and Leshara soils are cultivated under irrigation. The Lesho soils produce abundant forage and, in some places, are moderately well suited to irrigated crops. The Lincoln soils are suitable only for grazing. Because of their high water table, the Sweetwater soils support a good stand of native tall grasses and can be used as range or meadow. The main crops on Bridgeport soils are wheat and sorghum; few fields are irrigated.

## 5. Pratt-Tivoli Association

*Hummocky and undulating, deep soils of the sandhills*

This association consists of a broad, irregular band of sandhills that are south of and adjacent to the valley of the Arkansas River. The association makes up about 14 percent of the county. Near the river the hills are dune shaped, steep, and choppy, but they are hummocky and gently undulating near the southern edge of the association (see fig. 3).

The Pratt soils are dominant in the association, but large areas of Tivoli soils also occur. The Pratt soils are in undulating areas next to the Manter soils in association 6, and in hummocky areas adjacent to steeper dunelike areas occupied by Tivoli fine sand. In the hummocky areas the Pratt soils are closely intermingled with Tivoli soils. The Pratt soils have a loamy fine sand surface layer and a heavy loamy fine sand subsoil. The Tivoli soils have a loose fine sand surface layer and subsoil.

Most of this association is used for range. Under good management, mixed stands of tall and mid grasses produce forage sufficient for grazing and for protecting the soils from erosion. Some areas of Pratt loamy fine sand are

used for cash crops of sorghum and wheat. Wind erosion, the main hazard on soils of this association, probably can be controlled by good management.

## 6. Manter-Satanta Association

*Nearly level and gently undulating loamy soils in areas adjacent to the sandhills*

This association extends in an irregular band across the central part of the county. It is between the Spearville-Richfield association on the south and the sandhills on the north. The association occupies nearly level and gently undulating areas (fig. 4). It makes up about 11 percent of the county.

The Manter soils are dominant in the association, but large areas of Satanta soils also occur. The Manter soils occupy the gently undulating areas along the southern boundary of the sandhills. They have a sandy loam surface layer and subsoil.

The Satanta soils occupy the nearly level to gently sloping areas farther away from the sandhills. These soils have a loamy surface layer and subsoil.

Also in this association are areas where Ulysses and Manter soils are closely intermingled. In these areas the Manter soils are on undulating convex ridges and knolls and Ulysses soils are in the intervening small flats.

Most of this association is used for cash crops of sorghum and wheat. Wind erosion is a hazard throughout the association and is particularly serious on the sandier soils. Water erosion is an additional hazard on the gently sloping loamy soils. On all these soils, careful management is needed that controls erosion and conserves water.

## 7. Richfield-Ulysses-Mansic Association

*Nearly level to sloping, deep, loamy soils of the Crooked Creek drainage area*

This association consists of two areas in the southern part of the county that are part of the Crooked Creek drainage basin. The association amounts to about 12 percent of the county. It is dominantly moderately sloping to sloping, but in some places the sides of valleys are steep.

The Richfield soils are dominant in the association, but large areas of Ulysses and of Mansic soils also occur. The Richfield soils occupy nearly level and gently sloping areas between the tributaries of Crooked Creek. These soils are silty, and their subsoil has subangular blocky structure.

The Ulysses soils are less sloping than the Mansic soils, but both are in the sloping areas. The Ulysses soils are silty and do not have a distinctly different surface layer and subsoil. The Mansic soils have a clay loam surface layer and subsoil.

Dale silt loam is a minor, but important, soil in this association. It occupies the nearly level, narrow alluvial valleys and fans along Crooked Creek. It is a deep, dark-colored soil that has developed in mixed deposits of alluvium and colluvium.

In this association most areas of the gently sloping and moderately sloping soils are cultivated. The main crops are wheat and sorghum. Wind and water erosion are serious hazards. The conservation of water is needed for profitable production of crops. Native grasses remain on the steeper, more broken slopes and are used for grazing.

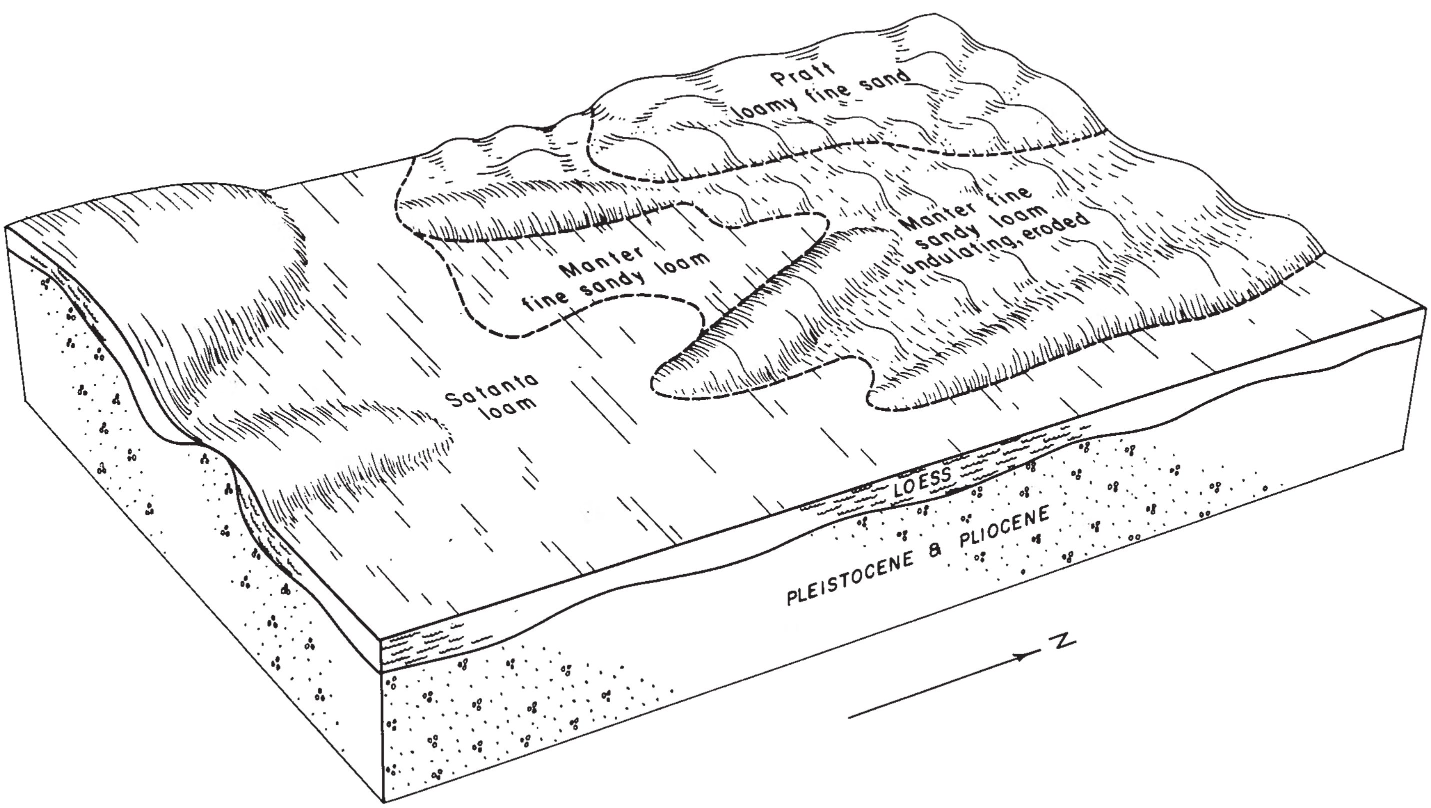


*Figure 4.*—**Soils of the Manter-Satanta soil association.**

## Effects of Erosion

Erosion is the removal of soil and geologic materials by natural agencies, mainly wind, running water, and gravity. This discussion deals with accelerated soil erosion, which should not be confused with geologic erosion. Geologic erosion is the gradual removal of soil under natural conditions in an undisturbed environment. Accelerated erosion is the increase in soil erosion brought about by manmade changes in the vegetation or in soil conditions.

Wind and water are the main active forces of soil erosion in Gray County. Wind erosion is always a hazard and becomes serious during the recurring periods of drought. Strong wind and limited vegetation that are characteristic of drought on the High Plains contribute to widespread soil movement.

Water erosion is a hazard on all the sloping, silty soils that are cultivated. Runoff and erosion occur during the hard, dashing thunderstorms when water falls faster than it enters the soil. Practices that slow or decrease runoff will conserve valuable moisture and help control water erosion.

The effects of erosion differ. Some are permanent and cause enough damage to require changes in use and management. Others may temporarily impair the soil until conservation practices are applied. Replanting crops, reseeding rangeland, and emergency tillage and smoothing may obliterate most of the temporary effects of erosion. Although these practices may restore full use of the soil, they are time consuming and costly.

During the course of the soil survey fieldwork, these effects of erosion were observed—

1. Small, low hummocks and drifts of soil form on nearly level and smoothly sloping cultivated fields where the soil is blowing. These "blow piles" will continue to blow unless the soil is smoothed and tilled to provide a roughened surface that resists erosion. If the surface is roughened by tillage to provide protection until vegetation grows, the soil will not be seriously or permanently damaged, and it can be restored to full use.
2. The top of ridges and knolls in the more undulating soils of the High Plains tableland are more vulnerable to wind action than areas of adjacent nearly level soils. Soil on exposed areas tends to blow more often and, consequently, much of it has been deposited on smoother areas nearby. Some of the finer soil particles are blown long distances. Much of the silt and sand deposited in the adjacent areas is calcareous. Because calcareous silty and sandy soils blow readily, wind erosion may occur after this material is deposited in a field that would otherwise be stable.
3. Soil may drift from actively eroding, cultivated fields to adjacent rangeland and damage or destroy the native vegetation. This damage is not permanent, but the use of the land is impaired until the grass has become established either by deferred grazing or by reseeding.
4. During drought, overuse of the very sandy, nonarable rangeland may result in the loss of protective vegetation and severe wind erosion. These areas are thus permanently damaged, and their value for grazing is greatly reduced. Also the drifting sand damages cultivated crops and grass in adjacent areas, and the sandy sediments increase the hazard of wind erosion on the soils on which they are deposited.

In Gray County, eroded soils are mapped as separate soil units only if erosion has modified some important quality or characteristic of the soil that is significant to use and management. Many of the soils have been eroded to some degree and are subject to further erosion.

An eroded soil is designated as an eroded phase of a soil type if it still retains many characteristics of the soil type. Some soils have been so altered by erosion that they now have characteristics similar to those of some closely associated soil, and they are mapped as such. For example, if the dark-colored surface layer has been removed from a soil that was once Ulysses silt loam, the soil is now designated as a Colby silt loam because it cannot be distinguished from that normally light-colored soil. Other soils have been extremely modified by erosion and have lost their identity as soils; these soils are now classified as miscellaneous land types. The miscellaneous land type Blown-out land was presumably another soil before it became eroded.

Measures needed to control erosion vary according to the kind of soil, the degree of slope, and land use. Some alternatives are generally possible when choosing a combination of practices that will control erosion on a given site. These practices are discussed more fully in the section "Managing Dryland Soils."

## Descriptions of the Soils

The soil series and mapping units of Gray County are described in this section. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series and then the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. Blown-out land, Gravelly broken land, and other miscellaneous land types are mapping units that do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the soil series.

A symbol in parentheses follows the name of each mapping unit and identifies it on the detailed soil map. Listed at the end of the description of a mapping unit are the dryland capability unit, irrigated capability unit, windbreak suitability group, and range site in which it has been placed. The pages on which the capability units, windbreak suitability groups, and range sites are described can be found by referring to the "Guide to Mapping Units" at the back of the survey.

Soil scientists, engineers, students, and others who want more information about soil series should turn to the section "Formation and Classification of Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary.

### Alluvial Land

Alluvial land (An) consists of loamy alluvium on valley floors and in the incised, meandering channels of intermittent streams in the uplands. The valley floors are at least 150 feet wide.

The soil material of this land type is dark grayish brown and generally is calcareous below a depth of 10 inches. The texture ranges from sandy loam to silty clay loam, but it is predominantly loam or silt loam.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

| Soil | Acres | Extent |
|---|---|---|
| Alluvial land | 3, 524 | 0. 6 |
| Blown-out land | 4, 619 | . 8 |
| Bridgeport silty clay loam, 0 to 1 percent slopes | 1, 520 | . 2 |
| Bridgeport silty clay loam, 1 to 3 percent slopes | 2, 444 | . 4 |
| Dale silt loam | 4, 240 | . 7 |
| Gravelly broken land | 1, 544 | . 3 |
| Harney silt loam, 0 to 1 percent slopes | 63, 685 | 11. 5 |
| Las Animas sandy loam | 1, 000 | . 2 |
| Las Animas soils | 4, 137 | . 8 |
| Las Animas-Lesho complex, alkali | 2, 856 | . 5 |
| Leshara clay loam | 1, 289 | . 2 |
| Lesho clay loam | 1, 916 | . 3 |
| Lesho-Sweetwater complex | 2, 320 | . 4 |
| Lincoln soils | 841 | . 1 |
| Lofton silty clay loam | 1, 583 | . 3 |
| Lubbock loam | 2, 045 | . 4 |
| Mansic clay loam, 3 to 6 percent slopes | 10, 717 | 2. 0 |
| Mansic complex, 3 to 6 percent slopes, eroded | 3, 569 | . 6 |
| Mansic clay loam, 6 to 15 percent slopes | 11, 220 | 2. 0 |
| Mansic complex, 6 to 15 percent slopes, eroded | 1, 111 | . 2 |
| Mansker-Potter complex | 617 | . 1 |
| Manter fine sandy loam, 0 to 1 percent slopes | 10, 839 | 1. 9 |
| Manter fine sandy loam, 1 to 3 percent slopes | 4, 310 | . 7 |
| Manter fine sandy loam, undulating, eroded | 13, 683 | 2. 4 |
| Manter-Ulysses complex, undulating | 7, 739 | 1. 3 |
| Pratt loamy fine sand, undulating | 44, 206 | 7. 9 |
| Pratt loamy fine sand, gravel substratum | 627 | . 1 |
| Pratt-Tivoli loamy fine sands | 25, 285 | 5. 0 |
| Randall clay | 10, 707 | 1. 9 |
| Richfield silt loam, 0 to 1 percent slopes | 77, 439 | 13. 9 |
| Richfield silt loam, 1 to 3 percent slopes | 20, 812 | 3. 7 |
| Richfield silty clay loam, 1 to 3 percent slopes, eroded | 1, 275 | . 2 |
| Richfield-Spearville complex, 0 to 1 percent slopes | 25, 807 | 4. 6 |
| Satanta loam, 0 to 1 percent slopes | 13, 885 | 2. 5 |
| Satanta loam, 1 to 3 percent slopes | 2, 044 | . 4 |
| Spearville silty clay loam, 0 to 1 percent slopes | 121, 430 | 22. 0 |
| Spearville complex, 1 to 3 percent slopes, eroded | 2, 206 | . 4 |
| Sweetwater soils | 897 | . 1 |
| Tivoli fine sand | 11, 930 | 2. 1 |
| Ulysses silt loam, 0 to 1 percent slopes | 9, 573 | 1. 8 |
| Ulysses silt loam, 1 to 3 percent slopes | 12, 342 | 2. 2 |
| Ulysses silt loam, 3 to 6 percent slopes | 7, 057 | 1. 3 |
| Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded | 4, 128 | . 8 |
| Arkansas River | 936 | . 1 |
| Intermittent lake | 206 | (1) |
| Total | 556, 160 | 100. 0 |

1 Less than 0.1 percent.

Alluvial land is almost entirely in range consisting of native grasses, for which it is well suited. It generally is not suitable for cultivation, because it is subject to occasional flooding and, in most places, is bordered by sloping soils that are not suitable for cultivation. Some isolated areas formed by meandering stream channels would be suitable for cultivation if they were not so small and so nearly inaccessible. (Capability unit VIw–1, dryland; not in an irrigated capability unit; Loamy Lowland windbreak suitability group; Loamy Lowland range site)

## Blown-out Land

Blown-out land (Bo) consists of areas where soil blowing has been extreme. These areas occur mainly within mapped areas of Pratt and Tivoli soils, and they include the blowouts, or eroded areas, and the adjoining land where loamy fine sand and sand have been deposited. The blowouts consist of light-colored, calcareous sandy loam to clay loam. The material deposited on adjacent land ranges from 10 to 20 inches in thickness.

Vegetation is sparse over much of Blown-out land. The blowouts are barren, or nearly so, and the areas covered by deposited material are in annual weeds and grasses.

This inextensive unit is not suited to crops. Erosion increases in cultivated areas, and they are generally abandoned. Reseeding areas now used for crops to suitable native grasses is a good practice. (Capability unit VIIe–1, dryland; not in an irrigated capability unit or windbreak suitability group; Choppy Sands range site)

## Bridgeport Series

The Bridgeport series consists of deep, well-drained soils formed in alluvium. These soils occupy nearly level to gently sloping alluvial fans and aprons along the northern border of the valley of the Arkansas River

The surface layer of these soils is dark grayish-brown, noncalcareous silty clay loam about 10 inches thick. The subsoil (AC horizon) is grayish-brown, calcareous silty clay loam to a depth of about 18 inches. Both the surface layer and subsoil have granular structure. The underlying material contains a high proportion of silt and, in some places, thin lenses of sand or a few pebbles. In most places the silt is loessal material washed from the uplands.

Typical profile of Bridgeport silty clay loam in a field where the slope is less than 1 percent (1,080 feet west and 360 feet north of the southeast corner of the NE¼ of sec. 10, T. 26 S., R. 28 W.):

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

AC—10 to 28 inches, grayish-brown (10YR 5/2, dry) silty clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; firm when moist, hard when dry; few worm casts; calcareous; gradual boundary.

C—28 to 65 inches, pale-brown (10YR 6/3, dry) silty clay loam, brown (10YR 5/3, moist); moderate, medium, granular structure; firm when moist, hard when dry; calcareous; numerous threads of lime.

The surface layer ranges from 6 to 15 inches in thickness. The subsoil (AC horizon) ranges from 13 to 22 inches in thickness and from silty clay loam to clay loam in texture.

The Bridgeport soils are deeper and better drained than the Leshara soils.

In Gray County the Bridgeport are the most extensive and productive soils in the valley of the Arkansas River. These fertile soils take in water fairly well and have a moderate water-holding capacity. Infrequent flash floods caused by runoff from the uplands damage crops and irrigation systems.

The Bridgeport soils produce satisfactory yields of wheat and sorghum if these crops follow summer fallow.

**Bridgeport silty clay loam, 0 to 1 percent slopes** (Bc).—This soil occurs on the high terraces along the northern edge of the valley of the Arkansas River. Included in the areas mapped are places that have a loam surface layer.

Most of this soil is irrigated. Yields of alfalfa, wheat, and sorghum are good. Limitations to farming are few, but conserving moisture and controlling wind erosion are problems. Moisture is conserved and the soil protected by keeping crop residue on the surface and by contour farming, stripcropping, and terracing. (Capability unit IIc-1, dryland, I-1, irrigated; Loamy Lowland windbreak suitability group; Loamy Terrace range site)

**Bridgeport silty clay loam, 1 to 3 percent slopes** (Bd).—This soil has an average slope of 2 percent. Included with it in mapping were small areas that have a sandy subsoil.

This Bridgeport silty clay loam is well suited to wheat and grain sorghum. In cultivated areas water erosion is the main hazard because runoff from higher adjacent soils is sometimes destructive. Diversion terraces are generally effective in controlling this water erosion. Other practices that protect the soil from erosion, and that help to conserve moisture as well, are keeping crop residue on the surface, terracing, contour farming, and stripcropping. (Capability unit IIIe–1 dryland, IIe–1, irrigated; Loamy Lowland windbreak suitability group; Loamy Terrace range site)

## Colby Series

The Colby series consists of thin, silty soils formed in calcareous loess. These soils occupy the sloping areas adjacent to tributaries of Crooked Creek and along the north side of the Arkansas River.

The surface layer of Colby soils, about 5 inches thick, is grayish-brown, friable, calcareous silt loam that has granular structure. The subsoil, to a depth of about 9 inches is slightly lighter colored silt loam, but it contains more clay than the surface layer. The underlying material is pale-brown, calcareous silt loam that feels floury but contains small, soft concretions of calcium carbonate.

In Gray County, Colby soils are mapped only in a complex with Ulysses soils.

Typical profile of Colby silt loam in a cultivated field where the slope is about 5 percent (225 feet south and 50 feet west of the northeast corner of NW¼ of sec. 21, T. 29 S., R. 29 W.):

Ap—0 to 5 inches, grayish-brown (10YR 5/2, dry) silt loam, dark grayish brown (10YR 4/2, moist); weakly granular; friable when moist, slightly hard when dry; calcareous; abrupt boundary.

AC—5 to 9 inches, brown (10YR 5/3, dry) silt loam, dark brown (10YR 4/3, moist); weak, medium, granular structure; many worm casts; calcareous; gradual boundary.

C1ca—9 to 30 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive; friable when moist, slightly hard when dry; calcareous; few, small, soft, white concretions of lime; gradual boundary.

C2—30 to 60 inches, very pale brown (10YR 7/3, dry) silt loam, pale brown (10YR 6/3, moist); massive; very friable when moist, soft when dry; calcareous.

The surface layer ranges from 3 to 6 inches in thickness.

The Colby soils are lighter colored and more calcareous in the surface layer than are the Ulysses soils and are less clayey in the subsoil than the Mansic soils.

Although Colby soils are not well suited to crops, some areas are cultivated. Because slopes are strong and the surface layer becomes sealed and slick during rainstorms, runoff from these soils is excessive. The excessive runoff causes considerable loss of soil material and damages crops that do not have a well-developed root system. Wind erosion is also a serious hazard both to the soil and to young plants.

## Dale Series

The Dale series consists of deep, well-drained soils formed in alluvium. These soils occupy nearly level terraces along Crooked Creek and upland swales that empty into Crooked Creek and the Arkansas River.

The surface layer is friable, noncalcareous silt loam that has granular structure. This layer is grayish brown to a depth of about 15 inches and is dark gray between 15 and 25 inches. The subsoil, to a depth of about 40 inches, is grayish-brown, calcareous silty clay loam that has granular structure. The underlying material contains a high proportion of silt that has been washed from the uplands.

Typical profile of Dale silt loam in a cultivated field where the slope is less than 1 percent (410 feet west and 225 feet south of the northeast corner of the NW¼ sec. 36, T. 29 S., R. 27 W.):

A11—0 to 15 inches, grayish-brown (10YR 5/2, dry) silt loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

A12—15 to 25 inches, dark-gray (10YR 4/1, dry) silt loam, very dark brown (10YR 2/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; many worm casts; noncalcareous; gradual boundary.

ACca—25 to 40 inches, grayish-brown (10YR 5/2, dry) silty clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; calcareous; few, small, soft concretions of lime; gradual boundary.

C—40 to 60 inches, light brownish-gray (10YR 6/2, dry) silt loam, dark grayish brown (10YR 4/2, moist); massive; friable when moist, slightly hard when dry; calcareous.

The surface layer (A11 and A12 horizons combined) ranges from 21 to 32 inches in thickness. The subsoil (ACca horizon) ranges from 7 to 25 inches in thickness and from silty clay loam to clay loam in texture. Weakly defined strata that are more loamy are common below a depth of 2 feet.

The Dale soils are less clayey and are noncalcareous to greater depths than the Bridgeport soils.

The Dale are among the most productive soils in the county. These soils absorb water readily and have a moderate water-holding capacity. Generally, crops are benefited by extra moisture gained through runoff from adjacent higher areas, but occasionally they are damaged by flash floods caused by this runoff. The Dale soils produce satisfactory yields of wheat and sorghum if these crops follow summer fallow.

**Dale silt loam** (0 to 1 percent slopes) (Da).—The profile of this soil is like the one described for the Dale series.

Wheat and grain sorghum are the principal crops, but alfalfa is grown in some areas. Moisture can be conserved and erosion controlled by managing crop residue, by stripcropping, and in suitable areas, by contour farming and terracing. (Capability unit IIc–2, dryland, I–1, irrigated; Loamy Lowland windbreak suitability group; Loamy Terrace range site)

## Gravelly Broken Land

Gravelly broken land (Gr) consists of sandy soil material that contains fine and coarse gravel. This land occurs on steep, broken side slopes of drainageways and on

the convex ridges that finger back into uplands along the north side of the Arkansas River.

In these areas the texture of the soil material is variable. The surface layer ranges from sandy loam to coarse sand, and the subsurface layer ranges from sandy loam to loamy sand. Pebbles are common throughout the profile.

All the acreage of this land type is in range consisting of native grasses. This land is suited to grazing if the range is managed to encourage the growth of native grasses. Proper stocking is essential, and deferred grazing or rotation-deferred grazing is a desirable practice. Locating fences, salt, and water at appropriate places helps to distribute livestock over the range so that it is grazed more uniformly. (Capability unit VIIs-1, dryland; not in an irrigated capability unit or windbreak suitability group; Gravelly Hills range site)

## Harney Series

The Harney series consists of deep, well-drained soils formed in loess. These soils occupy nearly level uplands in the northeastern and southeastern parts of the county.

The surface layer is dark grayish-brown, friable, noncalcareous silt loam that is about 9 inches thick and has granular structure. The subsoil is about 30 inches thick. Its upper part is noncalcareous silty clay loam that has weak prismatic structure breaking to subangular blocky structure. The lower part is silty clay that has moderate prismatic structure breaking to blocky structure. As depth in the lower part increases, the content of clay decreases and the material becomes calcareous and contains a few threads and hard concretions of calcium carbonate. The underlying material is very pale brown silt loam.

Typical profile of Harney silt loam in a cultivated field where the slope is less than 1 percent (210 feet north and 750 feet east of the southwest corner of NW¼ sec. 9, T. 28 S., R. 27 W.):

A1—0 to 9 inches, dark grayish-brown (10YR 4/2, dry) silt loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

B1—9 to 14 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

B21t—14 to 20 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); weak, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; firm when moist, hard when dry; patchy clay films on structural aggregates; noncalcareous; gradual boundary.

B22t—20 to 25 inches, dark grayish-brown (10YR 4/2, dry) silty clay, very dark grayish brown (10YR 3/2, moist); moderate, medium, prismatic structure that breaks to moderate, medium, blocky structure; very firm when moist, very hard when dry; distinct and continuous clay films on structural aggregates; noncalcareous; gradual boundary.

B3ca—25 to 39 inches, pale-brown (10YR 6/3, dry) silty clay loam, brown (10YR 5/3, moist); weak, medium and fine, subangular blocky structure; friable when moist, hard when dry; calcareous; few, hard, small concretions of calcium carbonate; gradual boundary.

C—39 to 65 inches, very pale brown (10YR 7/3, dry) silt loam, pale brown (10YR 6/3, moist); massive; friable when moist, slightly hard when dry; calcareous.

The surface layer ranges from 5 to 10 inches in thickness, and the subsoil (B horizons) ranges from 12 to 30 inches. In some places the C horizon has weak blocky structure and contains films and small concretions in the upper part. The lower part of the underlying material is massive and calcareous.

The Harney soils have a thicker surface layer than the Spearville soils. In contrast with the Richfield soils, Harney soils have a darker, thicker surface layer and a more compact, more clayey subsoil and are deeper to lime.

The Harney soils are fertile and take in water fairly well. They are well suited to irrigation. The chief requirements of management are controlling wind erosion and conserving moisture.

Most of the acreage of Harney soils is cultivated. Wheat and sorghum make satisfactory yields if these crops follow summer fallow.

**Harney silt loam, 0 to 1 percent slopes** (Ha).—This soil has the profile described for the Harney series. Included with this soil in mapping were small areas of Richfield silt loam, of Satanta loam, and of Spearville clay loam. The Richfield soil makes up about 7 percent of the unit; Satanta soil, about 4 percent; and Spearville soil, about 3 percent.

This Harney soil is well suited to wheat and to grain sorghum. Practices are needed to conserve moisture and control wind erosion. One such practice is keeping crop residue on the surface, but also desirable are contour farming, stripcropping, and terracing. (Capability unit IIc–1, dryland, I–1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

## Las Animas Series

Las Animas series consists of somewhat poorly drained, moderately deep soils formed in calcareous, sandy alluvium. These soils occur on nearly level bottom land along the Arkansas River.

The surface layer is grayish-brown, calcareous sandy loam about 11 inches thick. The subsoil (AC horizon), to a depth of about 30 inches, is grayish-brown, calcareous fine sandy loam that is marked with brownish and yellowish stains and blotches. Both the surface layer and subsoil have granular structure. The substratum consists of alluvial sand and gravel.

Typical profile of Las Animas sandy loam under native grass (0.4 mile south and 0.4 mile west of the northeast corner of sec. 13, T. 26 S., R. 27 W.):

A—0 to 11 inches, grayish-brown (10YR 5/2, dry) sandy loam, dark grayish brown (10YR 4/2, moist); weak granular structure; very friable when moist, soft when dry; calcareous; gradual boundary.

AC—11 to 30 inches, grayish-brown (10YR 5/2, dry) fine sandy loam, dark grayish brown (10YR 4/2, moist); common, fine, distinct, strong-brown mottles; weak granular structure; very friable when moist, soft when dry; calcareous; gradual boundary.

IIC—30 inches +, very pale brown (10YR 7/3, dry) sand, pale brown (10YR 6/3, moist); single grain (structureless); loose when dry or moist; calcareous.

The profile is commonly variable. The surface layer ranges from loamy sand to clay loam in texture and from 7 to 15 inches in thickness. Stratified sand, loamy sand, and clay loam in layers less than 6 inches thick are common in the subsoil. Depth to brownish and yellowish mottling ranges from 12 to 15 inches, and depth to coarse

sand and gravel ranges from 15 to 40 inches. The water table normally fluctuates between depths of 3 and 8 feet, but it may be higher or lower during periods when the amount of precipitation and of streamflow are extremely high or extremely low.

Las Animas soils are lighter colored and sandier throughout than Leshara soils and are better drained than the Sweetwater soils.

**Las Animas-Lesho complex, alkali** (0 to 1 percent slopes) (La).—The soils of this complex occur on the flood plain of the Arkansas River in areas so small and so intermingled that, for the purposes of the survey, it was not practical to map them separately. About 50 percent of this complex consists of Las Animas sandy loam; about 40 percent, of Lesho clay loam and sandy loam; and about 10 percent, of strongly saline-alkali soils (slick spots).

The Las Animas and Lesho soils in this complex contain more soluble salts and more alkali than the soils described for their respective series. The saline-alkali conditions vary. In some places the soils in this complex are excessively alkaline, but the content of soluble salts is low; in other places these soils are both strongly saline and strongly alkaline.

The slick spots occur in an irregular and discontinuous pattern throuthout the mapping unit. They occur as small depressions in pastures and as light-colored, cloddy, puddled clayey areas in cultivated fields. These slick spots are hard to cultivate because they have poor tilth and structure and because they stay wet longer than the surrounding soils.

Most areas of this complex are in permanent pasture. Under dryland farming, crop yields are spotty and generally poor, mainly because growth is impaired by the excessive amount of soluble salts. Conserving moisture and controlling wind erosion are additional problems that can be partly met by good management of crop residue. Under good grazing management, the native tall and mid grasses produce abundant forage. (Capability unit IVs–1 dryland; not in an irrigated capability unit; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

**Las Animas soils** (0 to 2 percent slopes) (Lc).—These somewhat poorly drained soils occur on the slightly uneven but nearly level parts of the flood plain of the Arkansas River. They have variable texture, color, and depth.

The surface layer of these soils ranges from loamy sand to clay loam. The subsoil ranges from loamy sand to sandy loam. Depth to sand and gravel ranges from about 18 to 36 inches. Most of the time the water table is between 3 and 6 feet below the surface, but it may be higher or lower when precipitation and streamflow are extremely high or extremely low.

Included in areas mapped as this soil are small areas of Lesho clay loam, Sweetwater soils, and Lincoln soils. These included soils make up about 15 percent of the mapping unit.

Because the moisture-holding capacity is low and erosion is likely, these soils are not suitable for cultivation. All of the acreage remains in tall and mid native grasses. Proper stocking is essential for insuring a good growth of these grasses, and deferred grazing or rotation-deferred grazing helps to maintain or even to improve productivity. (Capability unit VIs–1, dryland; not in an irrigated capability unit; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

**Las Animas sandy loam** (0 to 1 percent slopes) (Ld).—This soil occurs on the flood plain of the Arkansas River. The surface layer is grayish-brown sandy loam about 11 inches thick. It is calcareous and has weak granular structure. The subsoil, to a depth of about 30 inches is grayish-brown fine sandy loam to loam that has brownish and yellowish stains and blotches. It commonly contains stratified sand, loamy sand, and clay loam in layers less than 6 inches thick. Included in areas mapped as this soil are small areas of Leshara clay loam.

In most places Las Animas sandy loam is slightly saline, but in small local areas it is moderately to strongly saline. Although the water table fluctuates, it is below a depth of 6 feet for most of the growing season.

This soil is not well suited to crops under dryland farming, and it is only moderately well suited under irrigation. Wheat and sorghum are the main crops. Yields are limited by a fluctuating water table and the associated salinity. The additional problems of conserving moisture and controlling wind erosion can be met most effectively by managing crop residue well, but stripcropping can also be used. Abundant forage is produced on this soil where it is used for irrigated pasture or as range or meadow consisting of native grasses. (Capability unit IVw–2, dryland, IIIw–2, irrigated; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

## Leshara Series

The Leshara series consists of somewhat poorly drained, calcareous soils that formed in recent alluvium. These soils occur on the nearly level bottom land along the Arkansas River.

To a depth of about 40 inches is gray, calcareous clay loam that has granular structure. Brownish and grayish stains or blotches are in the lower part of this layer. Below this is alluvial sand and gravel.

Typical profile of Leshara clay loam in a nearly level cultivated field (1,650 feet north and 225 feet east of the southwest corner of sec. 27, T. 25 S., R. 29 W.):

A1—0 to 26 inches, gray (10YR 5/1, dry) clay loam, very dark gray (10YR 3/1, moist); moderate, medium, granular structure; friable when moist, hard when dry; calcareous; clear boundary.

AC—26 to 35 inches, gray (10YR 6/1, dry) clay loam, dark gray (10YR 4/1, moist); few, fine, faint, yellowish-brown mottles; moderate, fine, subangular blocky structure that breaks to moderate, medium, granular; firm when moist, hard when dry; calcareous; few hard concretions; gradual boundary.

C1—35 to 41 inches, light-gray (10YR 7/1, dry) clay loam, gray (10YR 6/1, moist); many, medium, prominent, yellow to yellowish-brown streaks and spots; moderate, fine, subangular blocky structure; firm when moist, hard when dry; calcareous; many hard concretions; gradual boundary.

IIC2—41 inches, very pale brown (10YR 7/3) coarse sand; single grain; loose when moist or dry.

The surface layer of Leshara soils ranges from 12 to 26 inches in thickness. The subsoil (AC and C1 horizons) is commonly stratified with thin layers ranging from sand to clay in texture. Depth to coarse sand and gravel ranges from about 30 to 50 inches and generally is about 36 to 40 inches. The water table normally fluctuates

between depths of 3 and 6 feet, but it may be higher or lower when precipitation and streamflow are extremely high or extremely low.

The Leshara soils have a finer textured, more coherent subsoil than Las Animas soils. They are deeper to coarse sand and gravel than the Lesho soils.

Most areas of Leshara soils are dryfarmed, but some are irrigated. Wheat and sorghum are the crops commonly grown, and they produce moderately good yields. Salinity, which is slight to moderate, has only a slight detrimental effect on the crops commonly grown.

**Leshara clay loam** (0 to 1 percent slopes) (Le).—This soil has the profile described for the Leshara series. It has a fluctuating water table and is slightly to moderately saline.

This soil is suited to wheat and to grain sorghum, though yields are reduced to some extent by the fluctuating water table and the associated salinity. Conserving moisture and controlling wind erosion are additional problems. Managing crop residue well is an effective way to conserve moisture and control erosion. (Capability unit IIIw-1, dryland, IIw-1, irrigated; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

## Lesho Series

The Lesho series consists of moderately deep, somewhat poorly drained, calcareous soils formed in recent alluvium. These soils occur on the nearly level bottom land along the Arkansas River.

The surface layer is dark grayish-brown, calcareous clay loam about 6 inches thick. The subsoil, to a depth of about 25 inches, is gray, calcareous clay loam that has brownish and grayish mottles. Both the surface layer and subsoil have granular structure. The substratum consists of alluvial sand and gravel.

Typical profile of Lesho clay loam (one-half mile east and 990 feet south of the northwest corner of sec. 13, T. 26 S., R. 29 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2, dry) clay loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; friable when moist, hard when dry; calcareous; clear boundary.

AC—6 to 14 inches, gray (10YR 5/1, dry) clay loam, very dark gray (10YR 3/1, moist); moderate, medium, granular structure; firm when moist, hard when dry; calcareous; gradual boundary.

C1—14 to 25 inches, gray (10YR 6/1, dry) clay loam, dark gray (10YR 4/1, moist); common, medium, distinct, yellowish-brown mottles; moderate, medium, granular structure; firm when moist, hard when dry; calcareous.

IIC2—25 inches +, very pale brown (10YR 7/3) coarse sand; single grain; loose when moist or dry.

The surface layer of Lesho soils ranges from 5 to 12 inches in thickness. Depth to yellowish-brown and gray mottles ranges from 11 to 25 inches, and depth to coarse sand and gravel ranges from 18 to 30 inches. The water table normally fluctuates between depths of 3 and 6 feet, but it may be higher or lower during periods when the amount of precipitation and streamflow are extremely high or extremely low.

The Lesho soils are shallower to coarse sand and gravel than the Leshara soils and generally are nearer to the Arkansas River.

Most areas of Lesho soils are dryfarmed, and the crops commonly grown are wheat and sorghum.

**Lesho clay loam** (0 to 1 percent slopes) (Lh).—This soil occurs on the flood plain of the Arkansas River. It has a fluctuating water table and is somewhat saline. Included with this soil in mapping were minor areas underlain by sand and gravel at a depth of 12 to 18 inches.

Lesho clay loam is not well suited to dryfarmed crops. It is moderately well suited to irrigated crops if it is irrigated late in summer when moisture is lacking. Wheat and grain sorghum are the major crops. The root zone is limited in thickness, and the fluctuating water table is detrimental to alfalfa and other deep-rooted crops. Yields of crops are reduced somewhat by the fluctuating water table and by salinity. The additional problems of conserving moisture and controlling wind erosion can be met effectively by managing crop residue well and by stripcropping. On range native grasses produce abundant forage. (Capability unit IVw-2, dryland, IIIw-1, irrigated; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

**Lesho-Sweetwater complex** (0 to 3 percent slopes) (Lk).—This complex of soils occurs along the outer edge of the Arkansas River flood plain in gently undulating to nearly level areas. The soils are in areas so small and so intermingled that it was not practical to map them separately. About 50 percent of the complex consists of Lesho loamy fine sand; about 25 percent, of Sweetwater soils; about 20 percent, of Las Animas soils; and about 5 percent, of Tivoli fine sand that is in mounds and has been blown onto the valley floor. Lesho loamy fine sand occupies the higher ridges about 2 to 4 feet above the depressions that are occupied by Sweetwater soils.

The surface layer of the Lesho soil is loamy fine sand; otherwise, the profile is similar to the one described for the Lesho series. The surface layer of the Sweetwater soil ranges from loamy sand to clay loam, but in other respects it is like the profile described as typical of the Sweetwater series. In this complex the Lesho and Sweetwater soils are not suited to cultivated crops, because the root zone is restricted, salinity is slight to moderate, the water table fluctuates, and wind erosion is likely. Most areas remain in meadows and pastures consisting of native grasses. Under good grazing management, the tall and mid grasses produce abundant forage. Proper stocking is essential, and deferred grazing is a good practice. Fences, salt, and water can be located so as to encourage livestock to graze the range evenly. (Capability unit VIs-1, dryland; not in an irrigated capability unit; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

## Lincoln Series

The Lincoln series consists of sandy soils that formed in slightly altered, very sandy alluvium on the nearly level to undulating flood plain of the Arkansas River. These soils are likely to be flooded frequently and to receive fresh deposits of soil materials.

The surface layer is about 8 inches thick and consists of grayish-brown, calcareous fine sandy loam that is marked with brownish and yellowish stains and blotches. It has platy structure. The material underlying the surface layer consists of stratified alluvial sand and gravel.

In Gray County, Lincoln soils are mapped only as an undifferentiated group.

Typical profile of Lincoln fine sandy loam (0.3 mile east and 0.1 mile south of the northeast corner of sec. 33, T. 25 S., R. 27 W.):

A—0 to 8 inches, grayish-brown (10YR 5/2, dry) fine sandy loam, dark grayish brown (10YR 4/2, moist); weak, thin, platy structure; very friable when moist, soft when dry; few, fine, faint, yellowish-brown mottles; calcareous; abrupt boundary.

IIC—8 inches +, very pale brown (10YR 7/3, dry) sand, yellowish brown (10YR 5/4, moist); single grain; loose when moist, soft when dry.

The Lincoln soils are variable in texture and color. The surface layer ranges from fine sand to clay loam in texture and from 6 to 18 inches in thickness. The water table in these soils is about the same height as the water level of the Arkansas River.

Lincoln soils are more sandy and are considerably shallower than Las Animas soils.

Lincoln soils are not suited to cultivated crops and are used mainly for pasture consisting of native grasses. These soils support a sparse growth of tall and mid grasses, groves of cottonwood trees, and in places where the water table is high, a dense growth of tamarisk and willow trees.

**Lincoln soils** (0 to 3 percent slopes) (Ll).—This undifferentiated group of soils occupies the narrow, unstable, low parts of the flood plain adjacent to the channel of the Arkansas River. These soils are variable in texture and unstable because they receive fresh deposits of soil materials in the frequent floods. Included with these soils in mapping were small areas of Las Animas soils and areas of gravel bars and riverwash that are outside the present river channel.

These soils are not suited to crops and are not farmed. Vegetation is sparse because of the floods in wet periods and the droughtiness in dry periods. Lincoln soils are susceptible to blowing, especially where they are not covered by growing plants. (Capability unit VIIw-1, dryland; not in an irrigated capability unit, windbreak suitability group, or range site)

## Lofton Series

The Lofton series consists of deep, clayey soils that formed in loess. These soils occupy nearly level benches around depressions scattered throughout the upland plains.

The surface layer, about 6 inches thick, is dark grayish-brown silty clay loam that is noncalcareous and has granular structure. The subsoil is dark-gray silty clay about 24 inches thick. It is noncalcareous and has blocky structure. The underlying material is pale-brown, calcareous silt loam that is massive.

Typical profile of Lofton silty clay loam in a cultivated field (660 feet south and 660 feet west of the northeast corner of sec. 16, T. 28 S., R. 28 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; firm when moist, hard when dry; noncalcareous; clear boundary.

B2t—6 to 30 inches, dark-gray (10YR 4/1, dry) silty clay, very dark gray (10YR 3/1, moist); moderate, fine, blocky structure; very firm when moist, extremely hard when dry; clay films distinct and continuous on structural aggregates; noncalcareous; gradual boundary.

C1ca—30 to 36 inches, very pale brown (10YR 7/3, dry) silty clay loam, pale brown (10YR 6/3, moist); massive; friable when moist, hard when dry; calcareous; faint films and streaks of segregated lime; gradual boundary.

C2—36 to 50 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive; friable when moist, slightly hard when dry; calcareous.

The surface layer of Lofton soils ranges from 5 to 12 inches in thickness. The subsoil (B2t horizon) ranges from 24 to 35 inches in thickness, and depth to calcareous material ranges from 28 to 40 inches.

Lofton soils have a darker colored subsoil and are deeper to free lime than Spearville soils. Their surface layer and subsoil are not so clayey nor so compact as those of the Randall soils.

**Lofton silty clay loam** (0 to 1 percent slopes) (Lo).—This soil occurs mainly on nearly level or slightly concave benches around depressions that are occupied by Randall soils.

Most areas of this soil are cultivated along with areas of surrounding soils. Because runoff received from surrounding soils drains away slowly, this soil is ponded occasionally and crops are damaged. Ponding is reduced by managing crops so that the surface layer is more porous and takes in more moisture. The residue also helps to protect the soil from erosion, but other practices are also needed to protect the soil against runoff from surrounding areas. (Capability unit IVw-1, dryland; not in an irrigated capability unit; Clayey Upland windbreak suitability group; Clay Upland range site)

## Lubbock Series

The Lubbock series consists of deep, well-drained soils that formed in a mixture of loess and silty material that washed from higher soils nearby. Lubbock soils occupy shallow swales and areas that are transitional between hardlands and sandy areas.

The surface layer, about 15 inches thick, is dark-gray, noncalcareous loam that has granular structure. The subsoil is about 38 inches thick and has three distinct layers. The upper layer is dark-gray clay loam that has granular structure; the middle layer is moderately slowly permeable, dark grayish-brown clay loam that has blocky structure, is very hard when dry, and is extremely firm when moist; the lower layer is grayish-brown, calcareous clay loam that has subangular blocky structure and a few threads of free lime. The underlying material is friable, calcareous clay loam that is massive.

Typical profile of Lubbock loam in a cultivated field where the slope is less than 1 percent (840 feet south and 750 feet west of the northeast corner of sec. 5, T. 28 S., R. 29 W.):

A1—0 to 15 inches, dark-gray (10YR 4/1, dry) loam, very dark brown (10YR 2/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B1—15 to 22 inches, dark-gray (10YR 4/1, dry) clay loam, very dark brown (10YR 2/2, moist); moderate, medium, granular structure; friable when moist, hard when dry; few worm casts; noncalcareous; gradual boundary.

B2t—22 to 36 inches, dark grayish-brown (10YR 4/2, dry) clay loam, very dark brown (10YR 2/2, moist); strong, medium, blocky structure; extremely firm when moist, very hard when dry; clay films prominent and continuous; noncalcareous; gradual boundary.

B3ca—36 to 53 inches, grayish-brown (10YR 5/2, dry) clay loam, dark grayish brown (10YR 4/2, moist); mod-

erate, medium, subangular blocky structure; friable when moist, hard when dry; calcareous; few threads of lime; gradual boundary.

Cca—53 to 60 inches, pale-brown (10YR 6/3, dry) clay loam, brown (10YR 5/3, moist); massive, but porous; friable when moist, slightly hard when dry; calcareous; many threads of lime.

The surface layer of Lubbock soils ranges from 9 to 20 inches in thickness. The subsoil (B horizons) ranges from 24 to 38 inches in thickness and from clay loam to silty clay loam in texture, but layers of fine sandy loam and clay are common. Depth to calcareous material is variable, but this material is generally below a depth of 24 inches.

The Lubbock soils have a thicker and darker surface layer and subsoil than those of typical soils on uplands in the county.

The fertile Lubbock soils take in water fairly well and have a high water-holding capacity. Crops on these soils are benefited occasionally by moisture received as runoff from adjacent higher soils. Water erosion is not a hazard, but wind erosion occurs where the soils are not covered by growing plants or crop residue.

Most areas of Lubbock soils are cultivated along with areas of adjacent soils.

**Lubbock loam** (0 to 1 percent slopes) (Lu).—This soil has the profile described for the Lubbock series. Included in mapping were small areas of Manter fine sandy loam, Richfield silt loam, Satanta loam, and Ulysses silt loam. The Manter soils make up about 5 percent of the unit, and Richfield, Satanta, and Ulysses soils together, about 7 percent.

This soil is well suited to wheat and to grain sorghum. Conserving moisture and controlling wind erosion are problems of management that can be partly met by keeping crop residue on the surface. Terracing, contour farming, and stripcropping are desirable practices. (Capability unit IIc–2, dryland, I–1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

## Mansic Series

The Mansic series consists of deep soils that formed in calcareous outwash of the High Plains. These soils occupy the sloping to moderately steep uplands.

The surface layer is grayish-brown, calcareous clay loam about 9 inches thick. The subsoil is light brownish-gray, calcareous clay loam to a depth of about 26 inches. Both the surface layer and subsoil have granular structure. The underlying material is very pale brown clay loam. The upper part has granular structure and contains soft fragments of caliche; the lower part is massive and is calcareous.

Typical profile of Mansic clay loam in a pasture of native grasses where the slope is about 6 percent (600 feet north and 450 feet east of the southwest corner of the NE ¼ of sec. 15, T. 28 S., R. 27 W.):

A—0 to 9 inches, grayish-brown (10YR 5/2, dry) clay loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

AC—9 to 26 inches, light brownish-gray (10YR 6/2, dry) clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; firm when moist, hard when dry; few worm casts; calcareous; few, small, hard concretions of calcium carbonate; gradual boundary.

C1ca—26 to 34 inches, light-gray (10YR 7/2, dry) clay loam, pale brown (10YR 6/3, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; calcareous; many, soft, white concretions of calcium carbonate; gradual boundary.

C2—34 to 50 inches, very pale brown (10YR 8/3, dry) clay loam, very pale brown (10YR 7/4, moist); massive; friable when moist, slightly hard when dry; calcareous; few, small, hard concretions of calcium carbonate.

The surface layer of Mansic soils ranges from 7 to 10 inches in thickness. Depth to free lime ranges from 0 to 7 inches.

The Mansic soils have a more clayey surface layer and subsoil than Ulysses soils. They have a less distinct zone of calcium carbonate accumulation than Mansker soils.

Most areas of Mansic soils remain under native short and mid grasses. These soils are subject to both wind and water erosion.

**Mansic clay loam, 3 to 6 percent slopes** (Md).—The profile of this soil is the one described for the Mansic series. This soil occupies short side slopes along some intermittent streams. Included in mapping were small areas of Ulysses silt loam and of Mansker loam.

Most areas of this soil are under native grass and are used for grazing, but some are cultivated mainly to wheat and to grain sorghum. Ways to conserve moisture and control wind and water erosion are using terraces, contour farming, and good management of crop residue. (Capability unit IVe–2, dryland, IIIe–4, irrigated; Loamy Upland windbreak suitability group Limy Upland range site)

**Mansic clay loam, 6 to 15 percent slopes** (Me).—This soil occupies the steeper side slopes and catsteps along intermittent streams. The surface layer and subsoil are slightly thinner than the ones in the profile described for the Mansic series. Included in mapping were small areas of Mansker loam and areas of grayish-brown to dark grayish-brown loamy soils in alluvium on valley floors less than 150 feet wide. These included areas make up about 15 percent of the mapping unit. Also included were Ulysses silt loam, 3 to 6 percent slopes, in areas of less than 10 acres.

Most areas of this soil are under native short grass and are used for grazing. Grazing management is needed that encourages the growth of the best native forage plants. This growth can be encouraged by proper stocking and by deferred grazing or rotation-deferred grazing. Fences, salt, and water can be located to help distribute livestock over the range. (Capability unit VIe–1; not in an irrigated capability unit; Loamy Upland windbreak suitability group; Limy Upland range site)

**Mansic complex, 3 to 6 percent slopes, eroded** (Mf).—This mapping unit occupies short slopes along some of the intermittent streams in the uplands. This complex originally was Mansic clay loam, 3 to 6 percent slopes, but now it cannot be classified as an individual Mansic soil, because about 35 percent of the area is so eroded that the surface layer is thinner and lighter colored than that of a Mansic soil. In some places much of the subsoil material has been removed, and hard concretions of calcium carbonate are scattered about on the surface.

Although this complex is not well suited to crops, most areas are cultivated mainly to wheat and grain sorghum. In most cultivated areas, erosion has thinned the surface soil, and tillage has mixed the lighter colored subsoil material with the remaining surface soil. Some areas of this

complex have been abandoned or have been reseeded to grass. Because slopes are strong and the surface is sealed and slickened, runoff is excessive during rainstorms. Rills and shallow gullies have formed at the bottom of slopes. In dry periods the unprotected areas of this complex blow readily.

Careful management and the use of terraces, contour farming, and crop residue are needed to conserve moisture and prevent further erosion by water and by wind. (Capability unit IVe–2, dryland, IIIe–4, irrigated; Loamy Upland windbreak suitability group; Limy Upland range site)

**Mansic complex, 6 to 15 percent slopes, eroded** (Mh).—This complex originally was Mansic clay loam, 6 to 15 percent slopes, but now only about 60 percent of the mapping unit consists of Mansic soils. About 25 percent has been so eroded that it does not have the characteristics of Mansic soils, and the remaining 15 percent consists of soils included in mapping such as those listed for Mansic clay loam, 6 to 15 percent slopes. The eroded areas of this complex are like Mansic clay loam, but the dark-colored surface layer is gone, and the pale brown to very pale brown underlying material is exposed.

The soils in this complex are so steep and eroded that they are not well suited to cultivated crops. Any areas now cultivated should be reseeded to suitable native grasses. (Capability unit VIe–1, dryland; not in an irrigated capability unit; Loamy Upland windbreak suitability group; Limy Upland range site)

## Mansker Series

The Mansker series consists of moderately deep, grayish-brown soils underlain by semihard caliche. These soils occupy the steeper side slopes along well-entrenched streams in the uplands.

The surface layer is grayish-brown, calcareous loam about 9 inches thick. The subsoil is light brownish-gray, calcareous loam to a depth of about 19 inches. Both the surface layer and subsoil have granular structure. The underlying material is white semihard caliche.

Typical profile of Mansker loam in a pasture of native grass (990 feet west and 450 feet north of the southeast corner of sec. 12, T. 26 S., R. 27 W.):

A—0 to 9 inches, grayish-brown (10YR 5/2, dry) loam, dark grayish brown (10YR 4/2, moist); weak, coarse, prismatic structure that breaks to weak, coarse, granular; friable when moist, hard when dry; calcareous; gradual boundary.

AC—9 to 19 inches, light brownish-gray (10YR 6/2, dry) loam, grayish brown (10YR 5/2, moist); weak, coarse, prismatic structure that breaks to weak, coarse, granular; friable when moist, hard when dry; calcareous; few, small, soft to semihard concretions of calcium carbonate; gradual boundary.

Cca—19 to 45 inches +, white, soft and semihard caliche.

The surface layer of these soils ranges from loam to clay loam. Depth to semihard caliche ranges from 14 to 26 inches.

Mansker soils are shallower than the Mansic soils and have a stronger zone of calcium carbonate accumulation. They are deeper to beds of indurated caliche than the Potter soils.

Most areas of Mansker soils remain under native short and mid grasses. This soil is subject to both water and wind erosion.

**Mansker-Potter complex** (6 to 15 percent slopes) (Mp).—This mapping unit occupies the broken areas adjacent to Buckner Creek and the steeper side slopes along well-entrenched upland drainageways on the north side of the Arkansas River. The soils of this complex are in areas so small and so intermingled that it was not practical to map them separately. From 65 to 85 percent of this complex is Mansker soils, and from 15 to 35 percent is Potter soils.

The Mansker soils in this complex have a profile like the one described for the Mansker series. A typical profile of Potter soils is described elsewhere in this survey under the Potter series.

The soils in this complex are suited to forage plants. They support a moderately good to good stand of native grasses, consisting chiefly of blue grama, sideoats grama, and little bluestream. Careful grazing management is needed to maintain good yields of forage. These soils are not suited to cultivated crops. (Capability unit VIe–3, dryland; not in an irrigated capability unit or windbreak suitability group; Mansker soil, Limy Upland range site; Potter soil, Breaks range site)

## Manter Series

The Manter series consists of well-drained soils that formed in sandy eolian sediments. These soils occupy nearly level to undulating areas that are transitional between the sandhills and hardlands.

The surface layer of these soils is grayish-brown, noncalcareous fine sandy loam about 6 inches thick. The subsoil, about 24 inches thick, is grayish-brown, friable fine sandy loam that, in the lower part, is calcareous and contains a few threads of lime. Both the surface layer and subsoil have granular structure. The underlying material is pale-brown, calcareous loam.

Typical profile of Manter fine sandy loam in a cultivated field where the slope is less than 1 percent (800 feet west and 200 feet north of the center of sec. 2, T. 27 S., R. 30 W.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2, dry) fine sandy loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable when moist, slightly hard when dry; noncalcareous; abrupt boundary.

B2—6 to 18 inches, grayish-brown (10YR 5/2, dry) fine sandy loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; many worm casts; noncalcareous; gradual boundary.

B3ca—18 to 30 inches, grayish-brown (10YR 5/2, dry) fine sandy loam, dark grayish brown (10YR 4/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; few worm casts; calcareous; many films of segregated calcium carbonate; gradual boundary.

C1ca—30 to 40 inches, pale-brown (10YR 6/3, dry) fine sandy loam, brown (10YR 5/3, moist); weak, granular structure; friable when moist, slightly hard when dry; calcareous; films of segregated calcium carbonate; gradual boundary.

C2—40 to 62 inches, pale-brown (10YR 6/3, dry) loam, brown (10YR 5/3, moist); massive, but porous; very friable when moist, soft when dry; calcareous.

The surface layer of Manter soils ranges from 4 to 11 inches in thickness. The subsoil (B horizons) ranges from 10 to 24 inches in thickness and from sandy loam to loam in texture. Texture of the underlying material ranges from loam or sandy loam to loamy fine sand.

Manter soils are darker colored and less sandy than Pratt soils. Throughout the profile, Manter soils are more sandy than Satanta soils.

Most areas of Manter soils are suited to crops and are cultivated mainly to sorghum and to wheat.

**Manter fine sandy loam, 0 to 1 percent slopes** (Mm).—The profile of this soil is the one described for the Manter series. This soil occupies nearly level sandy areas. In cultivated areas winnowing, or the blowing away of the fine particles, has left as much as 4 inches of loamy fine sand or light fine sandy loam on the surface. Included with this soil in mapping were minor areas of Manter fine sandy loam, undulating, eroded, and of Ulysses silt loam.

This soil is suited to wheat and to grain sorghum Soil blowing is a serious hazard, particularly when the soil is in summer fallow without protective cover. Soil blowing can be controlled or minimized, and soil moisture conserved as well, by keeping an adequate amount of crop residue on the surface continuously, but contour farming, stripcropping, and terracing can also be used. (Capability unit IIe–2, dryland, IIs–1, irrigated; Sandy Upland windbreak suitability group; Sandy range site)

**Manter fine sandy loam, 1 to 3 percent slopes** (Mn).—This soil has a thinner surface layer than Manter fine sandy loam, 0 to 1 percent slopes.

Wheat and grain sorghum are suitable crops, but soil blowing is a serious hazard in areas that are not protected by adequate plant cover. An adequate amount of crop residue kept on the surface continuously helps to conserve moisture and to protect this soil from erosion. Stripcropping is also a desirable practice. (Capability unit IIIe–3, dryland, IIIe–1, irrigated; Sandy Upland windbreak suitability group; Sandy range site)

**Manter fine sandy loam, undulating, eroded** (1 to 6 percent slopes) (Mo).—This soil has a thinner surface layer than the soil described for the Manter series, and it is calcareous nearer the surface. Topography ranges from undulating to weakly hummocky. The stronger convex slopes and the crests of knolls are more eroded than the lower lying areas and the concave slopes.

Included with this soil in mapping were minor areas of Richfield silt loam, Satanta loam, and Ulysses silt loam. Also included were small areas of fine sandy loam that are similar to Manter soils but are lighter colored and more calcareous.

The profile of this soil is commonly variable. As a result of winnowing and the loss of fine particles, the surface layer in many cultivated areas is loamy fine sand or light fine sandy loam to a depth of 2 to 4 inches, and in some areas it is calcareous at the surface. This layer is more sandy now than it was originally, and small blowouts, generally less than 1 acre in size, occur.

This soil has limited suitability for crops. Wheat and grain sorghum are the main crops grown, but wind erosion is likely, and windblown material may damage adjacent soils. Cultivation is safe only if this soil is carefully managed to control blowing. An adequate amount of crop residue kept on the surface continuously helps to control wind and water erosion and to conserve moisture. Stripcropping is also beneficial. Contour farming and terracing can be used in some places, but they are generally impractical because the slopes are complex. (Capability unit IVe–3, dryland, IIIe–1, irrigated; Sandy Upland windbreak suitability group; Sandy range site)

**Manter-Ulysses complex, undulating** (1 to 6 percent slopes) (Mu).—This mapping unit consists of Manter fine sandy loam and Ulysses silt loam in areas so intermingled that it was not practical to map these soils separately. About 55 percent of this complex consists of Manter fine sandy loam; about 25 percent, of Ulysses silt loam; and the remaining 20 percent, of small areas of Colby silt loam, Pratt loamy fine sand, and Richfield silt loam. This complex occurs as gently undulating ridges and mounds and the low flats between the mounds. Uneroded Manter soils occupy the gentle slopes that range from weakly convex to weakly concave, and eroded Manter soils are on the strongly convex knobs and ridges. Ulysses soils occupy the low flats between the mounds.

The Manter soils in this complex are similar to the soil described for the Manter series. A typical profile of Ulysses soil is described elsewhere in this survey under the Ulysses series. In this complex, however, the profiles of the Manter and Ulysses soils vary considerably from those of typical soils. As a result of winnowing, the texture of the top 2 to 4 inches of Ulysses soils in many cultivated fields ranges from sandy loam to loam or silt loam because the finer soil particles have been blown away.

Much of the acreage occupied by this complex is dry-farmed to wheat and sorghum. Soil blowing, a serious hazard, occurs in areas not protected by plant cover. Water erosion is also likely. An adequate amount of crop residue kept on the surface continuously helps to control wind and water erosion and to conserve moisture. Stripcropping is a desirable practice, but contour farming and terracing are generally impractical because the slopes are complex. (Manter soil: capability unit IIIe–3, dryland, IIIe–1, irrigated; Sandy Upland windbreak suitability group; Sandy range site. Ulysses soil: capability unit IIc–1, dryland, I–1 irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

## Potter Series

The Potter series consists of grayish-brown, shallow soils that are underlain by hard or semihard caliche. These soils occupy the steep side slopes and more broken areas that are well below the summit of the High Plains. The original mantle of loamy sediments has gradually been removed by geologic erosion, and the underlying caliche and weathered limestone have been exposed. In Gray County, Potter soils are mapped only in a complex with Mansker soils.

Typical profile of Potter clay loam in a pasture of native grass (1,080 feet north and 600 feet west of the southeast corner of sec. 4, T. 26 S., R. 27 W.):

A—0 to 8 inches, grayish-brown (10YR 5/2, dry) clay loam, dark grayish brown (10YR 4/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; calcareous; clear boundary.

R—8 inches +, very pale brown, hard caliche.

The surface layer of Potter soils ranges from 3 to 12 inches in thickness and from clay loam to loam in texture. Depth to caliche ranges from 3 to 12 inches. Almost barren outcrops of stony material are common.

The Potter soils are shallower to beds of indurated caliche than are the Mansker soils.

The Potter soils are inextensive in this county and are not suited to cultivated crops; they are suited to grazing.

They support a sparse stand of native grasses that consists chiefly of sideoats grama, blue grama, and little bluestem.

## Pratt Series

The Pratt series consists of deep, well-drained soils formed in moderately sandy eolian, or wind-deposited, material. These soils occupy the undulating to slightly hummocky areas of the sandy uplands.

The surface layer, about 11 inches thick, is brown loamy fine sand that is structureless, loose, and noncalcareous. The subsoil is brown, very friable loamy fine sand about 15 inches thick. It is noncalcareous and has granular structure. The substratum is light-colored, loose loamy fine sand.

Typical profile of Pratt loamy fine sand in a gently undulating cultivated field (300 feet west and 50 feet north of the southeast corner of sec. 3, T. 27 S., R. 28 W.):

A—0 to 11 inches, brown (10YR 5/3, dry) loamy fine sand, dark brown (10YR 4/3, moist); single grain (structureless); loose when moist or dry; noncalcareous; abrupt boundary.

B2t—11 to 26 inches, brown (10YR 5/3, dry) loamy fine sand, dark brown (10YR 4/3, moist); weak, medium, granular structure; very friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

C—26 to 60 inches +, pale-brown (10YR 6/3, dry) loamy fine sand, brown (10YR 5/3, moist); single grain (structureless); loose when moist or dry; noncalcareous.

The surface layer of Pratt soils ranges from 6 to 19 inches in thickness. The subsoil is light fine sandy loam or loamy fine sand.

The Pratt soils are sandier throughout than the Manter soils. They have a less sandy subsoil than the Tivoli soils and generally are smoother and less hummocky.

Most areas of Pratt soils remain in range that consists of native grasses.

**Pratt loamy fine sand, gravel substratum** (0 to 1 percent slopes) (Pg).—This soil occupies terraces that are 10 to 15 feet above the flood plain along the south side of the Arkansas River.

The surface layer, very friable loamy fine sand, is slightly darker colored than the surface layer of the soil described for the Pratt series. The subsoil ranges from loamy fine sand to sandy loam in texture and generally grades to a substratum of mixed sand and gravel below a depth of 40 inches.

Most of this soil is pastured, but some is cultivated. Areas that are dryfarmed are droughty. This soil is easy to work, and crops respond well to irrigation, but frequent applications of water are needed because the water-holding capacity is low. In irrigated areas yields of alfalfa and sorghum are fair. Soil blowing is a hazard in areas not adequately protected by plant cover. In areas not protected by growing plants, it is essential to keep an adequate amount of crop residue on the surface. (Capability unit IVe–1, dryland, IVs–1, irrigated; Sandy Upland windbreak suitability group; Sands range site)

**Pratt loamy fine sand, undulating** (1 to 6 percent slopes) (Pa).—The profile of this soil is like the one described for the Pratt series.

Because this soil has low moisture-holding capacity and is highly susceptible to blowing, it is not well suited to crops, particularly wheat. Grain sorghum is the principal crop. Stripcropping helps to control soil blowing, and keeping the surface covered continuously with crop residue is essential. The low moisture-holding capacity and susceptibility to blowing limit the effectiveness of summer fallow. (Capability unit IVe–1, dryland, IIIe–2, irrigated; Sandy Upland windbreak suitability group; Sands range site)

**Pratt-Tivoli loamy fine sands** (3 to 9 percent slopes) (Pt).—In this complex, the Pratt and the Tivoli soils are in areas so small and so intermingled that, for the purpose of the survey, it was not practical to map each soil separately. These soils are undulating to hummocky. About 70 to 85 percent of the complex is Pratt loamy fine sand, and about 15 to 30 percent is Tivoli loamy fine sand. The Tivoli soils occupy the tops of knolls on the larger and steeper hills, and the Pratt soils are on the side slopes and smoother parts. Included in areas mapped as this complex are small areas of Tivoli fine sand.

The Pratt soil in this complex has a profile like the one described for the Pratt series. The Tivoli soil has a loamy fine sand surface layer, but otherwise its profile is like the one described for the Tivoli series.

The Pratt and Tivoli soils in this complex are not suited to cultivated crops, because moisture-holding capacity is low and erosion is likely. Most areas remain in native range, but a few small areas are cultivated. Reseeding the cultivated areas to suitable native grasses is advisable, for blowing cannot be controlled where these soils are cropped.

Moderate to large amounts of forage are produced on these soils where grazing management is good. If these soils are used for range, proper stocking is essential, and deferred grazing or rotation-deferred grazing is a good practice. Fences, salt, and water can be located to help distribute the livestock over the range so that it is grazed more uniformly. (Capability unit VIe–2, dryland; not in an irrigated capability unit; Sandy Upland windbreak suitability group; Sands range site)

## Randall Series

The Randall series consists of deep, clayey soils that occupy depressions in the uplands. Locally these depressions are called potholes, or buffalo wallows. Because the depressions are enclosed and have no outlet, they hold water for periods ranging from several days to a week or more, or until it soaks into the soil or evaporates.

The surface layer, about 8 inches thick, is gray, very firm clay that has blocky structure. The subsoil, to a depth of about 30 inches, is dark-gray clay that is massive. It is sticky and plastic when wet and very hard when dry. The underlying material is pale-brown, calcareous silt loam.

Typical profile of Randall clay (900 feet east and 600 feet north of the southwest corner of sec. 36, T. 27 S., R. 30 W.):

A—0 to 8 inches, gray (10YR 5/1, dry) clay, dark gray (10YR 4/1, moist); strong, fine, blocky structure; very firm when moist, very hard when dry; noncalcareous; gradual boundary.

AC—8 to 30 inches, dark-gray (10YR 4/1, dry) clay, very dark gray (10YR 3/1, moist); massive; very firm when moist, very hard when dry, and sticky when wet; noncalcareous; gradual boundary.

C—30 to 60 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive, but porous; friable when moist, soft when dry; calcareous; few, small, soft concretions of calcium carbonate.

The surface layer of Randall soils ranges from silty clay loam to clay in texture. The subsoil (AC horizon) ranges from 24 to 40 inches in thickness.

The Randall soils have a grayer and more clayey surface layer and subsoil than the nearby Spearville, Richfield, and Satanta soils.

Most large areas of Randall soils are in range; the small areas are generally farmed like the surrounding soils.

**Randall clay** (0 to 1 percent slopes) (Ra).—The profile of this soil is the one described for the Randall series.

When this soil is farmed with the adjoining soils, ponding delays planting or harvesting if rainfall is heavy. Crops are frequently drowned out and are lost unless they are replanted. Because the kinds of native plants and the amount of forage are so variable, this soil is not well suited as range. Also, ponding damages the native grasses. Most uncultivated areas of this soil are either bare or have a sparse stand of western wheatgrass. Wind erosion is likely in dry periods unless a sufficient amount of crop residue is kept on the surface to protect it. (Capability unit VIw-2; not in an irrigated capability unit, windbreak suitability group, or range site)

## Richfield Series

The Richfield series consists of deep, well-drained soils formed in loess. These soils occupy nearly level to gently sloping uplands in the northern and southern parts of the county.

The surface layer, about 6 inches thick, is dark grayish-brown silt loam, is noncalcareous, and has granular structure. The subsoil is silty clay loam about 17 inches thick. It is granular in the upper part and subangular blocky in the lower part. The underlying material is pale-brown silt loam. The upper part is subangular blocky and contains small, soft concretions of calcium carbonate; the lower part is massive and calcareous.

Typical profile of Richfield silt loam in a cultivated field where the slope is less than 1 percent (660 feet east and 120 feet north of the southwest corner of sec. 13, T. 28 S., R. 30 W.):

A1p—0 to 6 inches, dark grayish-brown (10YR 4/2, dry) silt loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

B21t—6 to 13 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; few worm casts; noncalcareous; gradual boundary.

B22t—13 to 19 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); moderate, fine, subangular blocky structure; firm when moist, hard when dry; patchy clay films on structural aggregates; noncalcareous; gradual boundary.

B3ca—19 to 23 inches, brown (10YR 5/3, dry) silty clay loam, dark brown (10YR 4/3, moist); weak, fine, subangular blocky structure; friable when moist, slightly hard when dry; few worm casts; calcareous; gradual boundary.

C1ca—23 to 36 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); weak, medium, subangular blocky structure; friable when moist, slightly hard when dry; calcareous; less than 1 percent of soil mass is small, soft concretions of calcium carbonate; gradual boundary.

C2—36 to 60 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive; very friable when moist, soft when dry; calcareous.

The surface layer of Richfield soils ranges from 4 to 8 inches in thickness, and the subsoil (B horizons) ranges from 8 to 20 inches.

The Richfield soils have a thinner surface layer than the Harney soils, are less clayey in the subsoil, and are shallower to lime. Their subsoil is more friable than that of Spearville soils and less friable than that of Ulysses soils.

Most areas of Richfield soils are cultivated. Wheat and grain sorghum have satisfactory yields if these crops follow summer fallow. Water that can be used by growing plants is taken in fairly well, and irrigation is suitable. These soils are susceptible to wind and water erosion.

**Richfield silt loam, 0 to 1 percent slopes** (Rm).—This soil has the profile described for the Richfield series. Included in mapping were small areas of Ulysses silt loam. Harney silt loam, Spearville silty clay loam, and Satanta loam. The Ulysses soil makes up about 5 percent of the unit; Harney soil, about 4 percent; Spearville soil, about 3 percent; and Satanta soil, about 3 percent.

This soil is well suited to wheat and to grain sorghum. Water can be conserved and wind erosion controlled by keeping growing plants on the soil, by keeping crop residue on the surface, and by leaving the surface cloddy after tillage. Also beneficial are contour farming, stripcropping, and terracing. (Capability unit IIc-1, dryland, I-1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Richfield silt loam, 1 to 3 percent slopes** (Rn).—Except that it is more sloping, this soil is like Richfield silt loam, 0 to 1 percent slopes. The surface layer in cultivated fields is slightly thinner than the surface layer in native pasture. Included with this soil in mapping were small areas of Ulysses silt loam, which make up about 10 percent of the unit.

This soil is well suited to wheat and to grain sorghum. Controlling wind erosion and conserving moisture are problems of management in all areas, and water erosion is a hazard in the more sloping areas. Terracing, contour farming, and good management of crop residue are practices that help to control runoff and erosion. Contour stripcropping is also beneficial. (Capability unit IIe-1, dryland and irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Richfield silty clay loam, 1 to 3 percent slopes, eroded** (Ro).—This soil occurs mainly on side slopes along drainageways. Much of the original surface layer has been removed through erosion, and lime generally occurs below the plow layer.

This soil is well suited to wheat and to grain sorghum. Careful management is needed that conserves moisture and controls erosion by wind and by water. Terracing, contour farming, and good management of crop residue are essential, and stripcropping is advisable. (Capability unit IIIe-1, dryland, IIe-1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Richfield-Spearville complex, 0 to 1 percent slopes** (Rs).—This complex of soils occurs in the northwestern part of the county in nearly level areas where weakly convex and weakly concave slopes alternate. The soils in this complex are so intermingled that mapping them separately was not practical. About 60 percent of the unit consists of Richfield silt loam; about 30 percent, of

Spearville silty clay loam; and the remaining 10 percent, of Ulysses silt loam and Harney silt loam.

The Richfield soils in this complex are similar to the soil described for the Richfield series. A typical profile of Spearville soil is described under the Spearville series.

Nearly all the acreage of this complex is cultivated. Wheat and sorghum make satisfactory yields if these crops follow summer fallow. Moisture can be conserved and wind erosion controlled by keeping growing plants on the soil, by keeping crop residue on the surface, and by leaving the surface cloddy after tillage. Other desirable practices are contour farming, stripcropping, and terracing. (Richfield soil: capability unit IIc-1, dryland, I-1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site. Spearville soil: capability unit IIs-1, dryland, IIs-2, irrigated; Clayey Upland windbreak suitability group; Clay Upland range site)

## Satanta Series

The Satanta series consists of deep, well-drained soils that formed in loamy loess or similar material. These soils occupy the nearly level to gently sloping upland areas that are transitional between the hardlands and the sandy lands.

The surface layer, about 10 inches thick, is dark grayish brown, noncalcareous loam. The subsoil is about 22 inches thick. The upper part is brown loam, and the lower part is clay loam that is calcareous and contains a few threads of lime. Both the surface layer and subsoil have granular structure. The underlying material is pale-brown, friable, calcareous silt loam that is massive.

Typical profile of Satanta loam in a cultivated field where the slope is less than 1 percent (1,200 feet south and 100 feet east of the northwest corner of sec. 19, T. 26 S., R. 30 W.):

A1—0 to 10 inches, dark grayish-brown (10YR 4/2, dry) loam, very dark grayish brown (10YR 3/2, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; gradual boundary.

B1—10 to 18 inches, brown (10YR 5/3, dry) loam, dark brown (10YR 4/3, moist); weak to moderate, medium, granular structure; friable when moist, slightly hard when dry; noncalcareous; many worm casts; gradual boundary.

B2t—18 to 29 inches, brown (10YR 5/3, dry) clay loam, dark brown (10YR 4/3, moist); moderate, medium, granular structure; friable when moist, hard when dry; noncalcareous; many worm casts; gradual boundary.

B2ca—29 to 32 inches, brown (10YR 5/3, dry) clay loam, dark brown (10YR 4/3, moist); weak, medium, granular structure; friable when moist, slightly hard when dry; calcareous; thin films and streaks of segregated lime; gradual boundary.

C—32 to 50 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive; very friable when moist, soft when dry; calcareous.

The surface layer of these soils ranges from 6 to 12 inches in thickness. The subsoil (B horizons) ranges from 12 to 22 inches in thickness and from clay loam to silty clay loam in texture.

The Satanta soils have a thicker, darker surface layer than Ulysses soils and are deeper and leached of lime to a greater depth. Satanta soils are lighter colored and deeper to lime than Richfield soils. The subsoil of Satanta soils is less sandy than that of Manter soils.

Most areas of Satanta soils are cultivated. Wheat and sorghum produce satisfactory yields if these crops follow summer fallow. These fertile soils take in water well so that it can be used by growing plants, but they are susceptible to wind and water erosion.

**Satanta loam, 0 to 1 percent slopes** (Sa).—The profile of this soil is the one described for the Satanta series.

Included with this soil in mapping were some cultivated areas that have a sandy loam surface layer as a result of winnowing. Also included were minor areas of Ulysses silt loam, Lubbock loam, and Manter fine sandy loam.

This soil is well suited to wheat and to grain sorghum. To some extent, moisture can be conserved and wind erosion controlled by keeping crop residue on the surface. Also desirable are contour farming, stripcropping, and terracing. (Capability unit IIc-1, dryland, I-1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Satanta loam, 1 to 3 percent slopes** (Sb).—This soil is similar to the soil described for the Satanta series, but it is more sloping, and in some cultivated fields it has a slightly thinner surface layer.

This soil is well suited to wheat and to grain sorghum. Moisture can be conserved and water and wind erosion controlled by terracing, contour farming, and good management of crop residue. Contour stripcropping is also a good practice. (Capability unit IIe-1, dryland and irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

## Spearville Series

The Spearville series consists of deep, well-drained soils formed in loess. These soils occupy the nearly level and gently sloping uplands in the northern and southwestern parts of the county. The surface layer, about 7 inches thick, is dark grayish-brown silty clay loam that has granular structure. The subsoil is about 19 inches thick. The upper part is noncalcareous, slowly permeable silty clay that has blocky structure (fig. 5). The lower part is silty clay loam that has blocky structure, is calcareous, and contains a few small, soft concretions of lime. Because the subsoil is sticky when wet and very hard when dry, it is called gumbo by farmers. The underlying material is pale-brown, calcareous silt loam that has fine, subangular blocky structure.

Typical profile of Spearville silty clay loam in a cultivated field where the slope is less than 1 percent (200 feet north and 100 feet east of the southwest corner of sec. 17, T. 25 S., R. 27 W.):

A1—0 to 7 inches, dark grayish-brown (10YR 4/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable when moist, hard when dry; noncalcareous; clear boundary.

B2t—7 to 20 inches, grayish-brown (10YR 5/2, dry) silty clay, very dark grayish brown (10YR 3/2, moist); moderate to weak, medium, blocky structure; very firm when moist, very hard when dry; clay films prominent and continuous; noncalcareous; gradual boundary.

B3ca—20 to 26 inches, grayish-brown (10YR 5/2, dry) silty clay loam, dark grayish brown (10YR 4/2, moist); moderate, medium, blocky structure; firm when moist, hard when dry; clay films patchy; calcareous; few, small, soft concretions of lime; gradual boundary.

C—26 to 60 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3) when moist; weak, fine, subangular blocky structure; friable when moist, slightly hard when dry; calcareous; few small, soft concretions of lime.

*Figure 5.*—**Profile of Spearville silty clay loam. The slowly permeable subsoil is below a depth of about 7 inches.**

The surface layer of Spearville soils ranges from 5 to 9 inches in thickness, and the subsoil (B horizons) ranges from 12 to 26 inches.

The subsoil of Spearville soils is compact and more firm than that of the Richfield soils. In contrast with the Harney soils, Spearville soils have a thinner surface layer and a firm, compact subsoil.

Spearville soils have high water-holding capacity. Although water intake is slow, these soils are well drained because the underlying material is permeable.

Most areas of Spearville soils are cultivated. These soils are suited to winter wheat and to grain sorghum, but they are better suited to wheat. Sorghum grows slowly in these clayey soils because this crop requires the peak amount of water during the hot summer months when rainfall is low. These soils are somewhat difficult to till because the surface layer is clayey. After rains a crust often forms on the surface and hinders the penetration of sorghum seedlings.

**Spearville silty clay loam, 0 to 1 percent slopes** (Sp).—This soil has the profile described for the Spearville series. Included with it in mapping were small areas of Richfield silt loam and Harney silt loam. Richfield soils make up about 12 percent of the mapping unit, and Harney soils make up about 3 percent.

Because this soil is somewhat droughty, it is better suited to winter wheat than to grain sorghum. This droughtiness and surface crusting are the main features limiting use, but wind erosion is also important. Careful management of crop residue and minimum tillage are effective in conserving moisture, controlling erosion, and preventing surface crusting, but contour farming, terracing, and stripcropping are also desirable practices. Under careful management, crops on this soil respond to irrigation, and many fields are successfully irrigated. (Capability unit IIs–1, dryland, IIs–2, irrigated; Clayey Upland windbreak suitability group; Clay Upland range site)

**Spearville complex, 1 to 3 percent slopes, eroded** (Sr).—The soils of this complex are on the short side slopes bordering shallow, intermittent streams and around the heads of drains. About 65 percent of this complex is Spearville silty clay loam or silty clay, and about 30 percent consists of soils that are similar to Spearville but are calcareous within a depth of 15 inches or, in some places, at the surface. These calcareous soils have a thinner surface layer than Spearville soils, and in the places where they are calcareous at the surface, the surface layer is grayish brown or pale brown. The remaining 5 percent of the complex is made up of small areas of Richfield silt loam.

Because the soils in this complex are somewhat droughty, they are better suited to wheat than to grain sorghum. Conserving moisture, controlling water and wind erosion, and keeping the soils in good tilth are the major problems of management, and they can be met effectively by terracing, contour farming, and good management of crop residue. Stripcropping is also a desirable practice. (Capability unit IIIe–2, dryland, IIIe–3, irrigated; Clayey Upland windbreak suitability group; Clay Upland range site)

## Sweetwater Series

The Sweetwater series consists of poorly drained soils that formed in calcareous sandy alluvium. These soils occur on the flood plain of the Arkansas River.

The surface layer, about 5 inches thick, is dark-gray, calcareous clay loam that has granular structure. The upper part of the subsoil is gray, calcareous loam that has granular structure. The lower part is very pale brown, calcareous very fine sandy loam that is structureless and is marked with brown to yellowish stains or blotches. At a depth of about 26 inches is alluvial sand and gravel.

Typical profile of Sweetwater clay loam in a pasture of native grass (1,200 feet east and 20 feet south of the northwest corner of sec. 33, T. 25 S., R. 29 W.):

A—0 to 5 inches, dark-gray (10YR 4/1, dry) clay loam, very dark gray (10YR 3/1, moist); moderate, medium, granular structure; friable when moist, hard when dry; calcareous; clear boundary.

AC—5 to 11 inches, gray (10YR 5/1, dry) loam, very dark gray (10YR 3/1, moist); few, fine, faint, strong-brown mottles; moderate, medium, granular structure; friable when moist, slightly hard when dry; few worm casts; calcareous; gradual boundary.

C1—11 to 17 inches, light brownish-gray (10YR 6/2, dry) loam, dark grayish brown (10YR 4/2, moist); common, fine, distinct, strong-brown to brownish-yellow mottles; weak, medium, granular structure; friable when moist, slightly hard when dry; calcareous; gradual boundary.

C2—17 to 26 inches, very pale brown (10YR 7/3, dry) very fine sandy loam, pale brown (10YR 6/3, moist); many, medium, prominent, strong-brown to brownish-yellow mottles; structureless; very friable when moist, soft when dry; calcareous; gradual boundary.

IIC3—26 inches +, very pale brown (10YR 7/3) coarse sand and gravel; structureless; loose when moist or dry.

The surface layer of Sweetwater soils ranges from sandy loam to clay loam in texture and from 5 to 11 inches in thickness. Below a depth of about 12 inches, the alluvium has variable texture. Depth to ground water and to coarse sand and gravel ranges from about 20 to 36 inches.

Sweetwater soils are darker and more clayey than Las Animas soils. They are darker, are wetter, and have a more coherent subsoil than Lincoln soils.

Most areas of Sweetwater soils remain in native grass and are used as pasture or meadow (fig. 6). Under good grazing management, tall and mid grasses produce abundant forage. Slight salinity, wetness, and a restricted root zone limit the suitability of these soils for cultivated crops.

**Sweetwater soils** (0 to 1 percent slopes) (Sw).—The soils in this unit are like the soil described for the Sweetwater series. Included with this unit in mapping were small areas of Las Animas sandy loam and Lesho clay loam. These included soils make up about 5 percent of the unit.

Because they are wet and have a shallow root zone, the soils in this unit are not suited to cultivated crops. Under good grazing management, native tall and mid grasses produce abundant forage. The quality of the forage can be maintained or improved by proper stocking and by using deferred grazing or rotation-deferred grazing. (Capability unit Vw–1, dryland; not in an irrigated capability unit; Subirrigated Loamy Lowland windbreak suitability group; Saline Subirrigated range site)

***Figure 6.***—**Native grass on Sweetwater soils. The hay stacked in the background was cut from this meadow.**

## Tivoli Series

The Tivoli series consists of deep soils that formed in eolian sands. These soils occupy the undulating to steep, dunelike areas along the south side of the Arkansas River.

The surface layer, about 3 inches thick, is brown, noncalcareous fine sand that is loose and structureless. The underlying material is light yellowish-brown, noncalcareous fine sand.

Typical profile of Tivoli fine sand in a pasture of native grass (120 feet west and 100 feet south of the center of sec. 17, T. 26 S., R. 29 W.):

A—0 to 3 inches, brown (10YR 5/3, dry) fine sand, dark brown (10YR 4/3, moist); single grain; loose when moist or dry; noncalcareous; gradual boundary.

C—3 to 48 inches, light yellowish-brown (10YR 6/4, dry) fine sand, yellowish brown (10YR 5/4, moist); single grain; loose when moist or dry; noncalcareous.

The surface layer of Tivoli soils ranges from 2 to 10 inches in thickness (fig. 7).

Tivoli soils have a more sandy subsoil than Pratt soils and are more strongly sloping.

**Tivoli fine sand** (6 to 20 percent slopes) (Tf).—This soil has the profile described for the Tivoli series. Included with this soil in mapping were small areas of Pratt loamy fine sand. These included areas make up about 10 percent of the unit. Also included were small blowouts that are scattered throughout the unit.


***Figure 7.***—**A profile of Tivoli fine sand. The thin, dark surface layer is underlain by sand.**

This soil is not suited to cultivated crops, because it has low fertility, has low moisture-holding capacity, and is susceptible to wind erosion. It produces a fair to good stand of native grasses and is good for grazing when properly managed. Proper stocking is essential where this soil is used for grazing. Deferred grazing or rotation-deferred grazing can also be used. Fences, salt, and water can be located so that livestock graze the range more evenly. Fencing blowouts against livestock and then reseeding the blown-out areas to native grasses help to stabilize them. (Capability unit VIIe–1, dryland; not in an irrigated capability unit or windbreak suitability group; Choppy Sand range site)

## Ulysses Series

The Ulysses series consists of deep, well-drained soils formed in loess. These soils occupy the nearly level to sloping uplands throughout the county.

The surface layer, about 5 inches thick, is grayish-brown, friable, noncalcareous silt loam that has granular structure. The subsoil, about 9 inches thick, is also grayish brown, but it is slightly finer textured than the surface layer. The underlying material is pale-brown, calcareous silt loam that feels floury and contains lime films and a few concretions of calcium carbonate.

Typical profile of Ulysses silt loam in a cultivated field where the slope is less than 1 percent (330 feet south and 120 feet east of the northwest corner of the NE¼, sec. 32, T. 27 S., R. 27 W.):

Ap—0 to 5 inches, grayish-brown (10YR 5/2, dry) silt loam, very dark grayish brown (10YR 3/2, moist); weak, granular structure; friable when moist, slightly hard when dry; noncalcareous; clear boundary.

B2—5 to 14 inches, grayish-brown (10YR 5/2, dry) silty clay loam, very dark grayish brown (10YR 3/2, moist); moderate, medium, granular structure; friable when moist, slightly hard when dry; few worm casts; noncalcareous; gradual boundary.

C1ca—14 to 35 inches, pale-brown (10YR 6/3, dry) silt loam, brown (10YR 5/3, moist); massive; friable when moist, slightly hard when dry; calcareous; few, small, soft, white concretions of lime; gradual boundary.

C2—35 to 60 inches, very pale brown (10YR 7/3, dry) silt loam, pale brown (10YR 6/3, moist); massive, but porous; very friable when moist, soft when dry; calcareous.

The surface layer of these soils ranges from about 4 to 10 inches in thickness (fig. 8). Depth to free lime ranges from 0 to 15 inches.

Ulysses soils are darker throughout than Colby soils and have a thicker surface layer. They have a less clayey and more friable subsoil than Richfield soils.

Wheat and sorghum are grown in the nearly level to gently sloping areas of these soils, and the steeper areas are used mostly for pasture. Erosion is difficult to control in the steeper cultivated area. In the native grass pastures grazing has been so close that most of the tall grasses have been eliminated.

**Ulysses silt loam, 0 to 1 percent slopes** (Ua).—This soil has the profile described for the Ulysses series. Included with this soil in mapping were small areas of Richfield silt loam. These areas make up about 10 percent of the unit.

This soil is well suited to wheat and to grain sorghum. Moisture can be conserved and erosion controlled by keeping crop residue on the surface, but contour farming, stripcropping, and terracing are also desirable practices.

*Figure* **8.—Profile of Ulysses silt loam.**

(Capability unit IIc–1, dryland, I–1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Ulysses silt loam, 1 to 3 percent slopes** (Ub).—This soil has a profile similar to the one described for the Ulysses series, but, in general, the dark-colored surface layer is not so thick as the one described, and calcareous material is not so deep. Included with this soil in mapping were small areas of Richfield silt loam. These areas make up about 10 percent of the unit.

This soil is well suited to wheat and to grain sorghum. Moisture can be conserved and wind and water controlled by using terraces, contour farming, and good management of crop residue. Stripcropping is also beneficial. (Capability unit IIIe–1, dryland, IIe–1, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Ulysses silt loam, 3 to 6 percent slopes** (Uc).—This soil occupies side slopes adjacent to the deeper drainageways. Included with this soil in mapping were small areas of Mansic clay loam that make up about 5 percent of the unit.

Most areas of this soil are in permanent pasture, but some are cultivated. Wheat and grain sorghum are the main crops. Because this soil is sloping, runoff is rapid and water erosion is a serious hazard. Wind erosion is also a hazard where the soil is not protected by growing plants or by crop residue. Terraces, contour farming, and good management of crop residue are effective in controlling erosion. (Capability unit IVe–2, dryland, IIIe–4, irrigated; Loamy Upland windbreak suitability group; Loamy Upland range site)

**Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded** (Um).—The soils in this complex are so intermingled that mapping them separately was not practical. This complex occupies side slopes along tributaries of Crooked Creek and small areas in drainageways along the north side of the Arkansas River. About 55 percent of this complex consists of Ulysses silt loam; about 35 percent, Colby silt loam; and about 10 percent, Mansic clay loam.

A profile of Ulysses soil is described for the Ulysses series. A profile of Colby soil is described for the Colby series.

Most of the acreage in this complex is cultivated to wheat and to grain sorghum. Because the soils are sloping, runoff is rapid and water erosion is a serious hazard. Wind erosion is also a serious hazard where the soils are not protected by growing plants or by crop residue. Careful management that conserves moisture and prevents further erosion includes terracing, contour farming, and managing crop residue well. (Both soils in capability unit IVe-2, dryland, IIIe-4, irrigated, and in Loamy Upland windbreak suitability group. Ulysses soil: Loamy Upland range site; Colby soil: Limy Upland range site)

# *Use and Management of Soils*

The soils of Gray County are used mostly for dryfarmed crops, but a considerable acreage is irrigated. This section explains how the soils may be managed for these main purposes and also as range, for windbreaks, for wildlife, and in building highways, farm ponds, and other engineering structures. Also given are predicted yields of principal crops under dryland farming and irrigated farming.

The management of dryland and irrigated crops and of range is discussed by groups of similar soils. Also provided for groups of soils, in table 4, is information that is helpful in planning the management of windbreaks. To learn the names of soils in each of the interpretative groupings refer to the "Guide to Mapping Units" at the back of this survey.

## Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groupings, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Capability classes are defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclass. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-2 or IIIe-3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation; and the Arabic numeral specifically identifies the capability unit within the subclass.

All the soils in the county have been placed in dryland capability units according to their suitability for dryfarming, and those soils suitable for irrigation have been placed in irrigated capability units according to their suitability for irrigated farming. After a short discussion on management of dryland soils, the capability units in Gray County are described and suggestions for use and management of the soils are given.

## Managing Dryland Soils [2]

In Gray County, the soil is protected from erosion and moisture is conserved by keeping a cover on the surface all the time. Restoring the native plants is not necessary, but, as in nature, some kind of plant cover must be provided.

Suitable cropping systems, stubble mulching, and minimum tillage are needed on all cropland. Terracing, contouring, and stripcropping are additional practices that can be used effectively to control erosion by wind and by water. Soil and water are controlled best when a suitable combination of these practices is used, though a single practice may reduce erosion, conserve some moisture, or do both. In addition to conserving moisture and controlling erosion, the practices used should maintain fertility and provide good soil tilth. Most good farming practices accomplish more than one purpose and can be used on most of the cropland in the county.

In the following paragraphs, several practices suitable for use in managing dryland soils are discussed.

*A conservation cropping system* is a sequence of crops, suitable for a specified area, that are grown under appropriate management for a period of time. The system may consist of a regular rotation of different crops, or it may consist of only one crop grown year after year in the same area. In a flexible system there is no definite order for the crops to succeed one another.

The cropping system and other practices used to meet the objectives of dryland management keep damage by wind and water to a minimum and maintain or increase the productivity of the soil.

In Gray County the principal crops; winter wheat and grain sorghum, are commonly grown in the sequence summer fallow, winter wheat, and grain sorghum. Most farmers, however, prefer to keep their cropping systems flexible so that they can vary the kinds of crops planted according to the amount of moisture in the subsoil, the need for protective cover on the soil, and the economic needs of his particular farm.

*In residue management* enough crop residue is kept on the surface to protect the soil until protection is provided by a growing crop. The residue on the surface reduces the loss of soil and water, increases the intake of water, and helps to maintain the content of organic matter in the soil. Additional benefits are protection of the soil from extreme temperatures and increased activity of living organisms in the soil.

*Summer fallow,* as applied to dryfarmed areas, refers to keeping the soil free of plants during one crop season so that moisture will be stored for use by a crop the following season. Generally, crops grown after summer fallow produce better yields.

*Tillage* in a dryfarmed area is used to manage crop residue, to control weeds, and to prepare a suitable seedbed for crops. It is also used to roughen the surface of an unprotected soil and leave the soil cloddy so that damage from soil blowing is reduced. Surface roughening is called emergency tillage.

*In contour farming* all tillage and planting operations are performed parallel to terraces or contour guidelines. As a result, the furrows, ridges, and tracks made by farm machines are nearly level. Contour farming is most effective when used in combination with stubble mulching, terracing, stripcropping, or other good practices.

*Terracing* is used to intercept runoff. A terrace is a low embankment or ridge of earth that is built across a slope and that has a flat or graded channel. Terraces are constructed level so that water is held until it soaks into the soil, or they are constructed on a slight grade so that water is conducted slowly to a stable outlet or waterway. The main purposes of terraces, therefore, are to conserve moisture and help to control erosion.

*In stripcropping* crops are grown in narrow strips, or bands, that are arranged to serve as vegetative barriers to wind and water erosion. Strips of erosion-resistant crops or their residue are alternated with strips of other crops or of fallow. In Gray County erosion is resisted by good stands of growing wheat or grain sorghum and the thick, heavy stubble and residue left after the grain is harvested. These strips shorten the distance that loose soil can be blown and reduce the speed and carrying capacity of runoff.

### *Management of dryland soils by capability units*

In this subsection the groups of soils suitable for dryland farming are discussed. The significant features of the soils in each unit, together with their hazards and limitations, are described, and some suggestions are given for use and management of the soils.

#### CAPABILITY UNIT IIe-1 (DRYLAND)

This unit consists of deep, dark, fertile soils on gently sloping uplands. These soils have a silt loam or loam surface layer and a silty clay loam or clay loam subsoil. They are permeable and have a high moisture-holding capacity. Conserving moisture and controlling erosion are the main problems of management.

The soils in this unit are suited to wheat and grain sorghum. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are summer fallow to store moisture, crop residue to protect the soil, and minimum tillage to conserve moisture and to control erosion. In addition, terracing, contour farming, and contour stripcropping are effective in conserving moisture and controlling erosion.

#### CAPABILITY UNIT IIe-2 (DRYLAND)

This unit consists of only Manter fine sandy loam, 0 to 1 percent slopes. This is a deep, moderately dark, fertile soil in nearly level uplands. Its surface layer is fine sandy loam, and its subsoil ranges from sandy loam to loam.

This soil is easily penetrated by roots, air, and water and has high moisture-holding capacity. Susceptibility to wind erosion is the major hazard, and limitations caused by climate are of secondary importance.

This soil is well suited to sorghum, and wheat may be grown successfully if crop residue is used carefully to protect the soil against blowing. During extended periods of drought, crops must be planted only for the purpose of protecting the soil from wind erosion. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are crop residue to protect the soil and minimum tillage to conserve moisture and control erosion. Wind stripcropping, terracing, and contour farming are effective in reducing the hazard of erosion.

[2] Prepared by Earl J. Bondy, agronomist, Soil Conservation Service.

#### CAPABILITY UNIT IIs-1 (DRYLAND)

This unit consists of deep, dark, nearly level soils on uplands. These soils have a silty clay loam surface layer and a subsoil of firm, slowly permeable silty clay.

The soils of this unit are well drained, but runoff is slow. These soils have a high moisture-holding capacity, but they take in water slowly and release it slowly to plants. The material in the surface layer tends to run together and seal during rains. Other problems are low rainfall, recurrent drought, and wind erosion.

These soils are fertile and productive during years of above-normal rainfall. Crops on them are limited to wheat and sorghum. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are summer fallow to store moisture, crop residue to protect the soils and improve tilth, and minimum tillage to conserve moisture and to control erosion. Terracing, contour farming, and stripcropping are effective in reducing the hazard of erosion.

#### CAPABILITY UNIT IIc-1 (DRYLAND)

This unit consists of deep, dark, fertile soils on nearly level uplands and stream terraces. These soils have a silt loam, loam, or silty clay loam surface layer and a silty clay loam to clay loam subsoil.

The soils in this unit have high moisture-holding capacity and are readily penetrated by roots, air, and water. The conservation of moisture is the primary practice needed, but wind erosion is also a hazard. Crops on these soils are likely to be damaged by drought when rainfall is below average.

The soils of this unit are suited to wheat, grain sorghum, and forage sorghum. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are summer fallow to store moisture, crop residue to protect the soil, and minimum tillage to conserve moisture and to control erosion. In addition, contour farming, terracing, and stripcropping are effective in conserving moisture and controlling erosion.

#### CAPABILITY UNIT IIc-2 (DRYLAND)

This unit consists of deep, fertile soils in upland swales and on nearly level terraces. These soils have a silt loam or loam surface layer and a silt loam to clay loam subsoil.

These soils have a high water-holding capacity and are readily penetrated by roots, air, and water. Although some extra moisture is received as runoff from adjacent areas, conserving moisture and controlling wind erosion are problems.

These soils are suited to wheat and sorghum. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are crop residue to protect the soil, summer fallow to store moisture, and minimum tillage to conserve moisture and control erosion. In addition, terracing, contour farming, and stripcropping are effective in conserving moisture and controlling erosion.

#### CAPABILITY UNIT IIIe-1 (DRYLAND)

This unit consists of deep, moderately dark, fertile soils that occupy gently sloping uplands and alluvial fans. These soils have a silt loam, loam, clay loam, or silty clay loam surface layer. Their subsoil is silt loam, silty clay loam, or clay loam that contains much lime.

The soils in this unit have a high moisture-holding capacity and are readily penetrated by roots, air, and water. Water erosion is the main hazard, but wind erosion also occurs where the soils are not protected. Limitations by climate are only secondary.

These soils are suited to wheat and sorghum. Good management includes the selection of a cropping sequence according to the amount of available moisture. Also needed are crop residue to protect the soil, summer fallow to store moisture, and minimum tillage to conserve moisture and control erosion. In addition, terracing, contour farming, and stripcropping are effective in conserving moisture and controlling erosion.

#### CAPABILITY UNIT IIIe-2 (DRYLAND)

This unit consists of only Spearville complex, 1 to 3 percent slopes, eroded. The soils in this complex are deep and dark. They occur along shallow intermittent streams and around the head of drains in the uplands. The surface layer is silty clay loam, and the subsoil is slowly permeable, firm silty clay that is underlain by highly calcareous silty clay loam.

These soils have high moisture-holding capacity but slow intake of water. Water erosion is the main hazard, but wind erosion also occurs where the soils are not protected.

Under good management, these soils are suited to wheat and sorghum. Good management includes the selection of a cropping sequence according to the amount of moisture available. Also needed are crop residue to protect the soils, minimum tillage to conserve moisture and control erosion, and summer fallow to store moisture. Terracing and contour farming are also effective in reducing the hazard of erosion.

#### CAPABILITY UNIT IIIe-3 (DRYLAND)

This unit consists of deep, dark, fertile soils in gently sloping to undulating uplands. These soils have a fine sandy loam surface layer and a sandy loam to loam subsoil.

The soils of this unit are readily penetrated by roots, air, and water. They have moderate to high moisture-holding capacity. These soils are only moderately susceptible to water erosion, but wind erosion is a major hazard.

These soils are well suited to sorghum, and wheat can be grown successfully if crop residue is used carefully to protect the soil against blowing. Good management includes the selection of a cropping sequence according to the amount of moisture available. Especially needed are crop residue to protect the soil and minimum tillage to conserve moisture and control erosion. Terracing, contour farming, and stripcropping are other practices that help to control erosion.

#### CAPABILITY UNIT IIIw-1 (DRYLAND)

This unit consists of only Leshara clay loam. It is a deep, dark, somewhat poorly drained soil on the nearly level flood plain of the Arkansas River. The surface layer ranges from clay loam to loam, and the subsoil is clay loam. This soil is subject to occasional flooding, has a fluctuating water table that is near the surface much of the time, and is slightly saline to moderately alkaline.

Leshara clay loam is suited to sorghum and wheat. Good management includes the use of adapted crops in a suitable cropping sequence, of crop residue management

to protect the soil, and of minimum tillage to conserve moisture and to control erosion.

#### CAPABILITY UNIT IVe-1 (DRYLAND)

This unit consists of deep, light-colored, moderately fertile soils that are undulating to weakly hummocky. The surface layer and subsoil are loamy fine sand.

These soils take in water rapidly, but they have low to moderate moisture-holding capacity. Because the surface layer is coarse textured, wind erosion is the primary hazard, but low moisture-holding capacity is a secondary problem.

These soils are not well suited as cropland, though they can be used for crops. They are better suited as native grass range. If these soils are used as cropland, intensive practices that control wind erosion are needed. Good management includes stubble mulching, applying commercial fertilizer, wind stripcropping, and minimum tillage.

#### CAPABILITY UNIT IVe-2 (DRYLAND)

This unit consists of deep, moderately dark and light-colored, calcareous soils on sloping uplands. These soils have a silt loam or clay loam surface layer and a calcareous silt loam to silty clay loam or clay loam subsoil.

The soils of this unit have high moisture-holding capacity and are readily penetrated by roots. They contain little organic matter. Because the surface of these soils seals over during rainstorms, runoff is excessive and severe erosion is likely. Wind erosion is also a serious hazard where there is not enough protective cover.

These soils are not well suited as cropland, though they can be used for crops. They are better suited as native grass range. Yields of wheat and sorghum are generally low, but they are good in years when precipitation is above normal. These soils must be protected against water and wind erosion all of the time. During periods of prolonged drought, crops must be planted only for the purpose of providing protection from wind erosion. If these soils are used as cropland, a cropping sequence should be selected according to the amount of moisture available. Also needed are crop residue to protect the soil, minimum tillage to conserve moisture and control erosion, and terracing and contour farming to reduce the hazard of erosion.

#### CAPABILITY UNIT IVe-3 (DRYLAND)

This unit consists of only Manter fine sandy loam, undulating, eroded. This is a deep, moderately fertile, undulating soil in the uplands. The surface layer ranges from fine sandy loam to loamy fine sand, and the subsoil ranges from sandy loam to loam.

This soil is readily penetrated by roots, air, and water. It has moderate moisture-holding capacity. Wind erosion is the major hazard on this sandy soil, and limitations by climate are secondary.

The suitability of this soil for crops is limited, but sorghum and wheat can be grown if management is intensive and includes the use of stubble mulching to protect the soil and stripcropping and minimum tillage to control erosion.

#### CAPABILITY UNIT IVw-1 (DRYLAND)

This unit consists of only Lofton silty clay loam. It is a deep, dark, slowly permeable soil on nearly level benches around depressions in the uplands. The surface layer is silty clay loam, and the subsoil is silty clay.

This soil is somewhat droughty in dry periods. At other times, however, water may pond on the surface and damage crops because runoff is received from surrounding higher soils and surface drainage is slow.

In most places Lofton silty clay loam is managed the same as surrounding soils. If terracing, contour farming, minimum tillage, and crop residue management are used on the higher soils, much of the runoff is controlled and ponding is reduced.

#### CAPABILITY UNIT IVw-2 (DRYLAND)

This unit consists of moderately deep soils on the flood plain of the Arkansas River. Both the surface layer and subsoil range from sandy loam to clay loam in texture. These soils have a fluctuating water table that is near the surface much of the time, and salinity is slight to moderate. Flooding is likely at times, but at other times moisture needs to be conserved and wind erosion is likely.

These soils are not well suited as cropland. Crops may be damaged by flooding and by the high water table. Native grass range is a better use than crops. If these soils are used as cropland, a cropping sequence is needed that aids in controlling wind erosion, helps to store moisture for succeeding crops, and provides crop residue to protect the soils. On suitable sites, wind stripcropping can be used to help control wind erosion.

#### CAPABILITY UNIT IVs-1 (DRYLAND)

This unit consists of only the soils in Las Animas-Lesho complex, alkali. These soils occupy nearly level areas on the flood plain of the Arkansas River. The surface layer and subsoil range from sandy loam to clay loam. These soils are somewhat poorly drained, have a fluctuating water table that is near the surface much of the time, and are moderately to strongly saline-alkali.

The saline-alkali condition is not uniform; light-colored alkali spots, or slick spots, occur in cultivated fields and in slight depressions in pastures. Where these soils are cultivated, the surface layer becomes cloddy and puddled. Wind erosion is also a hazard, for soil blowing occurs when the surface is not protected by vegetation.

The soils in this unit are not well suited as cropland. They are better suited as native grass range. If these soils are used for crops, management is required that provides a sequence of crops that improve tilth and fertility. Also needed is management of crop residue to protect the soil against wind erosion.

#### CAPABILITY UNIT Vw-1 (DRYLAND)

This unit consists of only Sweetwater soils. These are shallow to moderately deep, poorly drained, nearly level soils along the Arkansas River. The surface layer ranges from sandy loam to clay loam, and the subsoil ranges from loamy sand to clay. These soils have a fluctuating water table that is near the surface much of the time, and they are slightly to moderately saline.

Because these soils are poorly drained, they are not well suited to cultivated crops. A better use is native grasses grown for hay or for pasture. Alkali sacaton, switchgrass, and other suitable grasses produce abundant forage, but range consisting of these grasses requires proper stocking, deferred grazing, and rotation-deferred grazing that maintain or improve productivity.

### CAPABILITY UNIT VIe-1 (DRYLAND)

This unit consists of deep, moderately dark and light-colored soils on the steeper side slopes along intermittent streams. Both the surface layer and subsoil are calcareous clay loam.

These soils have high moisture-holding capacity and are readily penetrated by roots, air, and water. Erosion by water and by wind is a serious hazard.

These soils are suitable only for use as grassland, and any areas now cultivated should be seeded to native grasses. Runoff and erosion are excessive where these soils are cultivated. If these soils are used as range, either natural or seeded, proper stocking, deferred grazing, and rotation-deferred grazing are needed. Sites on these soils are suitable for dams and ponds, mainly because in most places the soil material can hold water.

### CAPABILITY UNIT VIe-2 (DRYLAND)

This unit consists of only Pratt-Tivoli loamy fine sands. These are deep, light-colored, sandy soils in undulating to hummocky areas of the uplands. The surface layer is loamy fine sand, and the subsoil ranges from fine sand to loamy fine sand.

Rainfall is absorbed rapidly by these soils, and there is little runoff. But the soils do not hold a large amount of water, and wind erosion is a serious hazard in areas where protection is not adequate.

Because of their low moisture-holding capacity and susceptibility to wind erosion, these soils are suitable only as grassland. Blowouts form quickly in places where plant cover is destroyed by overgrazing or by trampling. If these soils are used as range, either natural or seeded, proper stocking and deferred grazing are needed. Blowouts and bare spots can be fenced and reseeded to native grasses. These soils are too sandy for impounded or dugout ponds, and water for livestock must be supplied by wells.

### CAPABILITY UNIT VIe-3 (DRYLAND)

This unit consists of shallow to moderately deep soils in steep, broken areas along drainageways in the uplands. The surface layer and subsoil range from loam to clay loam. Rock outcrops are common. These soils have low moisture-holding capacity and a restricted root zone.

These soils are suited as grassland. Runoff is excessive on the steeper, shallower soils. Water erosion and wind erosion are likely if the range is overgrazed and a good plant cover is not maintained. Proper stocking and deferred grazing are practices that maintain or improve native range.

### CAPABILITY UNIT VIw-1 (DRYLAND)

This unit consists of only Alluvial land. This land type is in narrow drainageways in the uplands, and it includes the meandering channels. It is nearly level along the valley floor, but it is steep, cut, and broken on the streambanks. The surface layer, mainly friable loam or silt loam, is underlain by calcareous material. Moisture-holding capacity is high, and additional water is received in occasional floods and from side drains.

Alluvial land is generally not suitable for farming. Areas that are not too steep for cultivation are small or are irregular in shape, and they are subject to flooding. In addition, these areas are generally almost inaccessible because they are adjacent to steep slopes. This land is suited as range, both natural and seeded, but proper stocking and deferred grazing are needed.

### CAPABILITY UNIT VIw-2 (DRYLAND)

This unit consists of only Randall clay. This soil is in upland depressions and is deep, dark, slowly permeable, and compact. Because this soil has very slow internal drainage and the depressions have no outlet, water collects and stands on the surface until it evaporates. During periods of high rainfall, the soil is ponded long enough to kill or injure plants, but it is droughty in prolonged dry periods. Wind erosion is a hazard, particularly in fields where a crop has been lost and no cover provided. Where this soil is used for crops, it is usually managed the same as the surrounding soils. Runoff can be reduced or diverted from this soil if terracing, contour farming, stubble mulching, and other practices are used on adjacent soils.

### CAPABILITY UNIT VIs-1 (DRYLAND)

This unit consists of moderately deep to shallow, nearly level, slightly to moderately saline-alkali soils on the flood plain of the Arkansas River. The surface layer and subsoil range from loamy sand to clay loam. These soils are shallow to moderately deep over sand.

The water table of these soils fluctuates between depths of about 3 and 10 feet, and salinity and alkalinity are slight to moderate. Wind erosion is also a hazard, for blowing occurs where the soils are not protected by plants.

These soils are not suited to cultivated crops. They are better suited as native grass meadows or pastures. Alkali sacaton, switchgrass, vine-mesquite, and other suitable grasses produce abundant forage, but proper stocking, deferred grazing, and rotation-deferred grazing are needed to maintain or improve productivity.

### CAPABILITY UNIT VIIe-1 (DRYLAND)

This unit consists of deep, light-colored fine sands that occupy undulating to steep, dunelike areas south of the Arkansas River. The surface layer and subsoil consist of fine sand.

These soils are rapidly permeable and have low moisture-holding capacity. Blowouts and bare areas of loose sand are common. Because most of the rainfall is absorbed as fast as it falls, runoff from these soils is negligible. These soils are droughty and highly susceptible to wind erosion.

These soils can be used as grassland, but plant cover must be maintained at all times for protection against blowing. Proper stocking and deferred grazing are needed to maintain or improve the stand of desirable native grasses. Blowouts and bare spots can be fenced and reseeded to suitable native grasses.

### CAPABILITY UNIT VIIw-1 (DRYLAND)

This unit consists of only Lincoln soils. These shallow, light-colored soils occur on the lower parts of the flood plain of the Arkansas River. The surface layer ranges from fine sand to clay loam and overlies coarse sand and gravel at a depth of generally less than 18 inches. Some areas consist of almost barren sandbars and gravel.

These soils have low moisture-holding capacity and a root zone that is restricted by the underlying gravel. Floods, which are likely, scour these soils in some places and deposit sand in other places. Also, the stream

channel often shifts. Another hazard is wind erosion in unprotected areas.

Use of these soils for native pasture is limited. The soils are unstable, mainly because of their low position on the flood plain. Also, the native plants vary from place to place. Some areas support a sparse stand of native tall grasses; some support groves of cottonwood trees interspersed with native grasses; and others support a mixed stand of cottonwood and willow trees and tamarisk shrubs. For this reason, the management required differs from place to place. Generally, grazing must be controlled so that the native grasses survive and remain vigorous. Control and eradication of brush may be desirable in places.

#### CAPABILITY UNIT VIIs-1 (DRYLAND)

This unit consists of only Gravelly broken land. This land type is shallow to moderately deep and coarse textured. It occupies the steep, broken side slopes along drainageways north of the valley of the Arkansas River. The surface layer ranges from sandy loam to coarse sand. The subsoil ranges from sandy loam to loamy sand and is underlain by sand and gravel at depths between 5 and 36 inches.

This land type has low moisture-holding capacity and a restricted root zone. Water erosion and wind erosion are likely where the land is overgrazed and a good cover is not maintained. Except for maintaining a good cover of grass through controlled grazing, little can be done to protect this land.

### *Predicted yields of crops (dryland)*

Table 2 gives the average yields per acre of dryfarmed wheat and grain sorghum that can be expected on suitable soils under common and improved management. These predictions were based on observations of members of the survey party and others familiar with the soils, on information obtained from farmers, and on results of tests made by the Kansas Agricultural Experiment Station. Records over a long period are necessary to account for fluctuations in yields caused by recurring and alternating periods of drought and high precipitation. Because no longtime, accurate records of yields are available, information is limited.

Predicted yields of wheat and sorghum to be expected over a long period under management commonly practiced in the county are shown in columns A. Yields that may be expected under improved management are shown in columns B.

*Common management.*—Under the prevailing, or most common, management, the following practices are used in producing wheat:

1. Tillage generally is parallel to field boundaries and not on the contour.
2. Tillage is frequent, and the equipment used eliminates the crop residue and leaves the soils bare.
3. Terraces generally are not used.
4. The cropping sequence used is alternate wheat and fallow or wheat, sorghum, and fallow. Winter wheat is seeded early in fall on soils that have been left idle but kept free of weeds during the summer. If the stand of wheat is not satisfactory or if the wheat is blown out, sorghum is planted in spring.

TABLE 2.—*Predicted average acre yields of the principal dryland crops*

[Yields in columns A are to be expected under common management; those in columns B are to be expected under improved management. Absence of yield data indicates that the soil is not suited to the crop ]

| Soil | Wheat | | Sorghum | |
|---|---|---|---|---|
| | A | B | A | B |
| | *Bu.* | *Bu.* | *Bu.* | *Bu.* |
| Bridgeport silty clay loam, 0 to 1 percent slopes | 17.0 | 20.0 | 24.0 | 32.0 |
| Bridgeport silty clay loam, 1 to 3 percent slopes | 15.0 | 18.0 | 21.0 | 30.0 |
| Dale silt loam | 19.0 | 22.0 | 29.0 | 38.0 |
| Harney silt loam, 0 to 1 percent slopes | 18.0 | 22.0 | 27.0 | 36.0 |
| Las Animas sandy loam | 11.0 | 14.0 | 16.0 | 21.0 |
| Las Animas-Lesho complex, alkali | 8.0 | 11.0 | 9.0 | 12.0 |
| Leshara clay loam | 14.0 | 17.0 | 20.0 | 27.0 |
| Lesho clay loam | 12.0 | 15.0 | 16.0 | 22.0 |
| Lofton silty clay loam | 12.0 | 16.0 | 19.0 | 25.0 |
| Lubbock loam | 20.0 | 23.0 | 25.0 | 33.0 |
| Mansic clay loam, 3 to 6 percent slopes | 10.0 | 14.0 | 14.0 | 20.0 |
| Mansic complex, 3 to 6 percent slopes, eroded | 9.0 | 13.0 | 12.0 | 18.0 |
| Manter fine sandy loam, 0 to 1 percent slopes | 15.0 | 20.0 | 25.0 | 31.0 |
| Manter fine sandy loam, 1 to 3 percent slopes | 13.0 | 17.0 | 23.0 | 29.0 |
| Manter fine sandy loam, undulating, eroded | 11.0 | 14.0 | 19.0 | 25.0 |
| Manter-Ulysses complex, undulating | 11.0 | 16.0 | 21.0 | 26.0 |
| Pratt loamy fine sand, undulating | 10.0 | 15.0 | 17.0 | 23.0 |
| Pratt loamy fine sand, gravel substratum | ------ | ----- | 12.0 | 16.0 |
| Richfield silt loam, 0 to 1 percent slopes | 17.0 | 21.0 | 24.0 | 32.0 |
| Richfield silt loam, 1 to 3 percent slopes | 15.0 | 19.0 | 21.0 | 30.0 |
| Richfield silty clay loam, 1 to 3 percent slopes, eroded | 14.0 | 18.0 | 20.0 | 29.0 |
| Richfield-Spearville complex, 0 to 1 percent slopes | 16.0 | 20.0 | 19.0 | 24.0 |
| Satanta loam, 0 to 1 percent slopes | 17.0 | 21.0 | 25.0 | 33.0 |
| Satanta loam, 1 to 3 percent slopes | 15.0 | 19.0 | 23.0 | 31.0 |
| Spearville silty clay loam, 0 to 1 percent slopes | 15.0 | 19.0 | 22.0 | 29.0 |
| Spearville complex, 1 to 3 percent slopes, eroded | 12.0 | 15.0 | 18.0 | 25.0 |
| Ulysses silt loam, 0 to 1 percent slopes | 16.0 | 20.0 | 23.0 | 31.0 |
| Ulysses silt loam, 1 to 3 percent slopes | 14.0 | 18.0 | 20.0 | 29.0 |
| Ulysses silt loam, 3 to 6 percent slopes | 12.0 | 16.0 | 19.0 | 28.0 |
| Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded | 11.0 | 15.0 | 16.0 | 26.0 |

5. Cropland is grazed after harvest if residue is available. Usually, both seeded and volunteer wheat are grazed during fall and winter.

Except for Manter and Pratt soils on which sorghum is generally grown continuously, the common management practices used in producing grain sorghum are:

1. The cropping sequence used is wheat, sorghum, and fallow. The soil is cultivated after the wheat has been harvested and is clean tilled until about June 1. Then sorghum is planted.

2. Sorghum is seeded with a drill or planter and is seldom cultivated. If the crop is cultivated, a rotary hoe or harrow is used.

*Improved management.*—The cropping sequence given for common management is also used under improved management. In addition, practices are used that protect the soil from erosion and conserve water. These practices are suggested for each soil under "Management of Dryland Soils by Capability Units." Generally, they include terracing, contour farming, minimum tillage, and good management of crop residue.

## Managing Irrigated Soils

Some of the soils in Gray County are well suited to irrigation. These soils are deep and have adequate moisture-holding capacity. Their permeability is moderately slow or slow, and internal drainage is good. Before most of these soils can be irrigated, however, leveling is needed so that the irrigation water is distributed uniformly. The irrigated soils in this county are used mainly for wheat, sorghum, and alfalfa.

If a farmer plans to irrigate his land, considering the following is advisable: (1) The suitability of the soils for irrigation; (2) the adequacy, reliability, and quality of the water supply; (3) the control and conveyance of the water; (4) total water requirements, estimated on the basis of the effective rainfall and the efficiency of the irrigation system; (5) the method of applying water; (6) drainage facilities needed to remove excess surface and subsurface water.

### *Management of irrigated soils by capability units*

When a soil is irrigated, the management needed generally differs from that needed when the soil is dryfarmed. For this reason, each soil in the county that is suited to irrigation is placed in a capability unit that has fewer limitations to use than it has when dryfarmed.

On the following pages, each irrigated capability unit is discussed. Each unit consists of soils that have about the same limitations and risks of damage under irrigation. Crops suited to the soils in each unit are named, and suitable practices for managing the soils are suggested.

#### CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of deep, nearly level soils on stream terraces and uplands. The surface layer of these soils is silt loam, loam, or silty clay loam, and the subsoil is loam, silty clay loam, or silty clay.

These soils have a slow to moderate water intake rate. They are well drained and fertile. Permeability is moderate to moderately slow, and moisture-holding capacity is high. These soils are easily worked and have few restrictions under irrigation.

Irrigated fields are well suited to wheat, sorghum, corn, alfalfa, beans, sugarbeets, and tame grasses. Among the practices that maintain or improve fertility and tilth are the use of crop residue for maintaining the content of organic matter, additions of fertilizer, and the use of a deep-rooted legume on some soils.

Engineering structures and practices that permit the most efficient use of irrigation water are needed. Land leveling is commonly needed to prepare soils for irrigation by gravity. Water is conveyed to the field through open ditches, surface pipes, or underground pipes, and it is distributed through gated pipes and siphon tubes into furrows and field borders. Managing runoff from adjacent higher areas is a problem on some fields.

#### CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of deep, gently sloping, loamy soils on uplands. The surface layer of these soils is silt loam, loam, silty clay loam, or clay loam, and the subsoil is silty clay loam or clay loam.

The soils of this unit have a slow to moderate water intake rate. They are well drained and fertile. Permeability is moderate to moderately slow, and moisture-holding capacity is high. Water erosion is the main hazard on these soils.

Irrigated fields are well suited to wheat, sorghum, corn, alfalfa, beans, and other adapted crops, but not much irrigation is done except on Bridgeport silty clay loam, 1 to 3 percent slopes. The water that is available in the uplands is generally used to irrigate soils that have slopes of less than 1 percent.

If these soils are irrigated, management is needed that provides for the control of erosion, the efficient use of water, and the maintenance of fertility and tilth. Fertility and tilth can be maintained or improved by using a cropping sequence that includes close-growing crops and deep-rooted legumes, by managing crop residue, and by adding commercial fertilizer and barnyard manure. Bench leveling, contour furrows, and sprinklers supplemented with terraces minimize the risk of erosion. Drops or underground pipes may be needed to control erosion and water in irrigation ditches.

#### CAPABILITY UNIT IIw-1 (IRRIGATED)

This unit consists of only Leshara clay loam. This is a deep, moderately dark, nearly level soil on the flood plain of the Arkansas River. The surface layer and subsoil are clay loam.

This soil is fertile, is moderately to slowly permeable, and has high moisture-holding capacity. It is somewhat poorly drained. Because the water table is moderately high and fluctuates, a slight to moderate amount of toxic salts accumulates in this soil in dry periods when the water table is relatively low.

Under irrigation, Leshara clay loam is suited to wheat, sorghum, alfalfa, and other adapted crops. Good management is needed that maintains and improves fertility and tilth, controls salinity, and provides the most efficient use of water. Ways of improving fertility and tilth, and of increasing the content of organic matter, are using a cropping sequence that includes legumes, managing crop residue, and adding commercial fertilizer. A heavy application of irrigation water before seeding reduces the accumulation of salt.

Required on this soil are a properly designed irrigation system and practices that provide the most efficient use of irrigation water. Land leveling is commonly needed to prepare this soil for irrigation by gravity. Water is conveyed to this soil through open ditches and surface pipes and is distributed through gated pipes and siphon tubes into furrows and bordered fields.

#### CAPABILITY UNIT IIs-1 (IRRIGATED)

This unit consists of only Manter fine sandy loam, 0 to 1 percent slopes. This deep soil is on nearly level uplands. The surface layer and subsoil are moderately dark colored fine sandy loam.

This soil has a moderately rapid water intake rate. It is fertile and well drained. Permeability is moderate and moisture-holding capacity is moderate to moderately high. Wind erosion is a hazard where the surface is unprotected.

Under irrigation, this soil is suited to wheat, sorghum, alfalfa, sugarbeets, and tame grasses. Good management is needed that maintains or improves fertility and tilth and provides the most efficient use of water. Ways of improving fertility and tilth are using a cropping sequence that includes legumes, managing crop residue, and adding commercial fertilizer and barnyard manure.

A properly designed irrigation system is needed for efficient use of water. In most places land leveling is required so that water is uniformly distributed. Lining ditches and conveying water through pipes are ways of preventing loss of water and increasing the efficiency of the system. Irrigation water is distributed on this soil through gated pipes and siphon tubes that empty into furrows and bordered fields.

#### CAPABILITY UNIT IIs-2 (IRRIGATED)

This unit consists of only Spearville silty clay loam, 0 to 1 percent slopes. This deep, nearly level, well-drained soil is in the uplands. The surface layer is silty clay loam, and the subsoil is silty clay.

The water intake rate of this soil is very slow, but moisture-holding capacity is high. Also high is the supply of plant nutrients. The firm, slowly permeable silty clay subsoil restricts the movement of roots, water, and air and is a primary limitation to irrigated use.

Under irrigation, this soil is suited to wheat, sorghum, corn, alfalfa, and other crops common in the area. Among the practices that maintain or improve soil structure, fertility, tilth, and content of organic matter are the use of crop residue, addition of commercial fertilizer and barnyard manure, and proper irrigation.

A properly designed irrigation system is needed for the most efficient use of water. Some land leveling is needed to prepare this soil for irrigation by gravity. Water is conveyed to fields through open ditches and surface pipes and is distributed through gated pipes and siphon tubes into furrows. Because this soil is fine textured, the tubes or streams of water should be small so that the water is taken into the soil and stored well. Also, water must be applied slowly over a long period and in frequent irrigations. A system for the safe removal of runoff from heavy rainstorms is essential on this soil.

#### CAPABILITY UNIT IIIe-1 (IRRIGATED)

This unit consists of deep, gently sloping soils in the uplands. The surface layer is fine sandy loam, and the subsoil is sandy loam or loam.

These soils have a moderately rapid water intake rate. They are fertile and well drained. Permeability is moderate, and moisture-holding capacity is moderate to moderately high. Wind erosion is a hazard.

Under irrigation, these soils are suited to wheat, sorghum, alfalfa, sugarbeets, and tame grasses, but not much of the acreage is irrigated. The water that is available in the uplands is generally used to irrigate soils that have slopes of less than 1 percent. If the soils in this unit are irrigated, management is needed that provides for the control of erosion, the efficient use of water, and the maintenance of fertility and tilth. Fertility and tilth can be maintained or improved by using a cropping sequence that includes deep-rooted legumes and by managing the crop residue and adding commercial fertilizer. Erosion can be controlled and water efficiently used by land leveling, irrigating on the contour, and using sprinkler irrigation on close-growing crops.

#### CAPABILITY UNIT IIIe-2 (IRRIGATED)

This unit consists of only Pratt loamy fine sand, undulating. This deep, gently sloping soil is in the uplands. The surface layer and subsoil are loamy fine sand.

This soil has a rapid water intake rate. Permeability is moderately rapid, and the moisture-holding capacity is moderate to low. This soil is highly susceptible to wind erosion.

Under irrigation, this soil is suited to sorghum and tame grasses. In irrigated areas, management is needed that provides for the control of wind erosion and the maintenance of fertility and tilth. The only practical way to irrigate this soil is by sprinklers.

#### CAPABILITY UNIT IIIe-3 (IRRIGATED)

This unit consists of only Spearville complex, 1 to 3 percent slopes, eroded. The soils in this complex are in the uplands and are deep and gently sloping. They have a silty clay loam surface layer and a firm, slowly permeable silty clay subsoil.

These soils have a very slow water intake rate. Moisture-holding capacity is high. Water erosion, slow permeability, and rapid runoff are the main hazards.

Under irrigation, the soils of this unit are suited to wheat, sorghum, and grasses, but not much of the acreage is irrigated. The water that is available in the uplands is generally used to irrigate soils that have slopes of less than 1 percent. If the soils in this unit are irrigated, management is needed that provides for the control of erosion, the efficient use of water, and the maintenance of fertility and tilth. Crop residue can be used to improve tilth and control erosion, and commercial fertilizer and barnyard manure can be used to maintain and improve fertility.

A well-designed irrigation system is necessary for efficient use of water. Contour benches and contour irrigation minimize the risk of erosion. Drops or underground pipes may be needed to control erosion, and drops can be used to control water in irrigation ditches.

#### CAPABILITY UNIT IIIe-4 (IRRIGATED)

This unit consists of deep, fertile, well-drained soils on sloping uplands. The surface layer is silt loam, loam, or clay loam, and the subsoil is silty clay loam or clay loam.

These soils have a moderate water intake rate. Permeability is moderate, and the moisture-holding capacity is high. Water erosion is likely, and the efficient use of irrigation water is a problem.

Under irrigation, these soils are suited to alfalfa, tame grasses, wheat, and sorghum, but none of the acreage is irrigated because the water that is available in the uplands is used to irrigate soils that have slopes of less than 1 percent. If the soils of this unit are irrigated, management is needed that provides for the control of erosion, the efficient use of water, and the maintenance of the organic-matter content, fertility, and tilth. Fertility and tilth can be maintained or improved by using a cropping sequence that includes close-growing crops and deep-rooted

legumes, by managing crop residue, and by adding commercial fertilizer. Bench leveling, contour furrows, and sprinkler irrigation supplemented with terraces minimize the risk of erosion. Drops or underground pipes may be needed to control erosion and water in irrigation ditches.

#### CAPABILITY UNIT IIIw-1 (IRRIGATED)

This unit consists of only Lesho clay loam. This soil is on the flood plain of the Arkansas River and is moderately deep, nearly level, and somewhat poorly drained. The surface layer and subsoil are clay loam.

Fertility is moderate on this soil. Water intake is slow, permeability is moderate to slow, and moisture-holding capacity is moderate. This soil is slightly to moderately saline because it has a high water table that fluctuates but is impractical to lower by drainage.

Irrigated fields are well suited to wheat and sorghum. Management is needed that maintains and improves fertility and tilth and controls salinity. Fertility and tilth can be improved, and the content of organic matter increased, by using a cropping sequence that includes legumes, by managing crop residue, and by adding commercial fertilizer. Heavy applications of water in winter and early in spring reduce the accumulation of salt and fill the root zone with water that can be used by the next crop.

Required on this soil are a properly designed irrigation system and practices that provide the most efficient use of irrigation water. Some land leveling is needed to prepare this soil for irrigation by gravity. Water is conveyed to fields through pipes and open ditches. Lining ditches prevents loss of water and erosion. Water is distributed through siphon tubes and gated pipes to furrows and bordered fields and through pipes to sprinklers.

#### CAPABILITY UNIT IIIw-2 (IRRIGATED)

This unit consists of only Las Animas sandy loam. This soil is on the flood plain of the Arkansas River and is moderately deep and nearly level. It has a sandy loam surface layer and subsoil.

This soil has a rapid water intake rate. Fertility is moderate, and moisture-holding capacity is low to moderate. The water table fluctuates, but it is impractical to lower it by drainage. Salinity is slight or moderate. The accumulation of salt is easily leached, however, when the water table is low.

Under irrigation, this soil is well suited to wheat and sorghum. Management is needed that maintains and improves fertility, uses irrigation water efficiently, and controls salinity. A cropping sequence that includes legumes and proper use of crop residue and commercial fertilizer help to maintain or improve fertility. Occasional leaching of the soil through irrigation, at a time when the water table is low, helps to control salinity.

Required on this soil are a properly designed irrigation system and other practices that provide the most efficient use of irrigation water. Some land leveling is needed to prepare this soil for irrigation by gravity. Sprinkler irrigation is more suitable, however, because intake of water and permeability are rapid.

#### CAPABILITY UNIT IVs-1 (IRRIGATED)

This unit consists of only Pratt loamy fine sand, gravel substratum. This soil is on high terraces south of the Arkansas River and is nearly level and moderately deep. The surface layer is loamy fine sand, and the subsoil is sandy loam to loamy fine sand. The substratum is a mixture of coarse sand and gravel. This soil has a very rapid intake rate. Permeability is rapid, and moisture-holding capacity is low. Wind erosion occurs where the surface is unprotected.

Irrigated fields can produce profitable yields of sorghum, but this soil is better suited to tame grasses or a mixture of sweetclover and alfalfa. The only suitable way to irrigate this soil is by sprinklers. Because permeability is rapid, frequent irrigation is required.

### *Predicted yields of crops (irrigated)*

Table 3 gives the predicted average yields per acre of irrigated wheat, grain sorghum, forage sorghum, and alfalfa on those soils most commonly irrigated in the county. The predicted yields are based on information obtained from farmers and from others familiar with irrigated soils.

Yields in columns A are those expected under common, or less intensive, management. Common management consists of using suitable varieties of crops, irrigating without land leveling, and adding only limited amounts of fertilizer. Yields in columns B are those expected under improved, or intensive, management. In improved management, land is leveled for better distribution of water, water is used efficiently, adequate amounts of fertilizer are added, and practices that conserve moisture and control erosion are used.

TABLE 3.—*Predicted average acre yields of irrigated crops*

[Yields in columns A are to be expected under common management; those in columns B are to be expected under improved management]

| Soils | Wheat | | Grain sorghum | | Forage sorghum (ensilage) | | Alfalfa | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| | *Bu.* | *Bu.* | *Bu.* | *Bu.* | *Tons* | *Tons* | *Tons* | *Tons* |
| Bridgeport silty clay loam, 0 to 1 percent slopes | 35 | 50 | 70 | 115 | 18 | 23 | 4 | 6 |
| Harney silt loam, 0 to 1 percent slopes | 40 | 50 | 75 | 115 | 19 | 24 | 4 | 6 |
| Richfield silt loam, 0 to 1 percent slopes | 40 | 50 | 75 | 115 | 19 | 24 | 4 | 6 |
| Satanta loam, 0 to 1 percent slopes | 40 | 50 | 75 | 115 | 19 | 24 | 4 | 6 |
| Spearville silty clay loam, 0 to 1 percent slopes | 30 | 40 | 65 | 100 | 16 | 21 | 3 | 6 |
| Ulysses silt loam, 0 to 1 percent slopes | 35 | 50 | 70 | 115 | 18 | 23 | 4 | 6 |

## Range Management [3]

Range is land that produces native grasses, forbs, and shrubs that are valuable for forage and are used for grazing. About 19 percent of Gray County is range. The range occurs primarily in the sandy areas south of the Arkansas River, in the breaks along the north side of the river, and in saline, subirrigated bottom lands along both sides of the river. Most areas of rangeland are not suited to cultivated crops, but they can produce range forage of high quality.

Livestock operators are primarily ranchers who raise mixed herds and whose income is mainly from the sale of calves and yearlings. Most of these ranchers use some bottom land along the river to produce hay and other winter feed.

### *Range sites and condition classes*

Different kinds of rangeland produce different kinds and amounts of grass and other plants used by livestock. For proper range management, an operator needs to know the different kinds of land or range sites in his holdings and the plants each site can produce. Management can then be used that favors the growth of the best forage plants in each range site.

*Range sites* are areas of rangeland that differ from each other in their ability to produce significantly different kinds and amounts of climax, or original, vegetation. A significant difference is one that is great enough to require different grazing practices, or other management that maintains or improves the present vegetation.

*Climax* vegetation is the combination of plants that ordinarily grow on a given site. The most productive combination of range plants on a range site is generally the climax type of vegetation.

Ranchers estimate the condition of their range to determine whether the range has improved or deteriorated. Range condition is classified according to the percentage of existing vegetation on a range site compared to the original, or climax, vegetation. Four condition classes are defined. Condition is *excellent* if 76 to 100 percent of the present vegetation is the same as that in the original stand; condition is *good* if the percentage is from 51 to 75; it is *fair* if the percentage is between 26 and 50; and it is *poor* if the percentage is 25 or less.

Most of the rangeland in Gray County is now producing only about one-fourth of its potential capacity. When rangeland is overused, yields of forage decrease, the better plants disappear, and more water runs off. This increased runoff results in increased wind and water erosion. But when rangeland is properly used, it takes in more water and produces larger yields of forage. If a range in poor or fair condition is properly used, the better plants increase in number and erosion is lessened. Also, the surface soil is improved through the accumulation of plant residue.

According to their behavior under grazing, plants on a range site are classed as *decreasers*, *increasers*, and *invaders*. *Decreasers* are plants of the original plant community that are preferred by livestock and that decrease in number under continued heavy grazing. Decreasers are plentiful when the range is in excellent condition. *Increasers* are the less palatable plants that increase for a while as decreasers are grazed off, but if heavy grazing is continued, other less palatable plants, or *invaders*, replace both the decreasers and increasers. Originally, the invaders made up a minor part of the plant community, but under heavy grazing, they generally continue to replace the more desirable plants.

[3] By GLEN P. SNELL, range conservationist, Soil Conservation Service.

### *Descriptions of range sites*

Described in the following pages are the range sites in the county, or groups of soils that have similar potential for producing range plants. The predicted yield of total herbage is given for each range site when it is in excellent condition. Also given are the principal decreasers, increasers, and invaders. To determine the soils that make up each range site, refer to the "Guide to Mapping Units" at the back of this survey.

#### SALINE SUBIRRIGATED RANGE SITE

This site consists of soils on bottom lands. The surface layer of these soils ranges from clay loam to loamy sand, and the subsoil ranges from sand to clay. A high concentration of salts limits the kinds and amount of plants on this site, but the plants that do grow are subirrigated during the growing season by a high water table.

Decreasers make up at least 90 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers may make up as much as 10 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Alkali sacaton. | Inland saltgrass. | Alkali muhly. |
| Switchgrass. | Sideoats grama. | Tamarisk. |
| Indiangrass. | Western wheatgrass. | |
| | Blue grama. | |
| | Sedges. | |

Generally, this site is in poor condition, and inland saltgrass and blue grama provide most of the forage. Where the site is used primarily for hay, it is in good or excellent condition.

When this site is in excellent condition, its total annual production ranges from 6,000 to 7,500 pounds of air-dry herbage per acre.

#### LOAMY LOWLAND RANGE SITE

This site consists of only one mapping unit, Alluvial land. This land is made up of deep, dark, loamy alluvium on flood plains. It is well drained, but floods are frequent during rainy periods.

Decreasers make up at least 60 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers may amount to as much as 40 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Switchgrass. | Western wheatgrass. | Silver bluestem. |
| Big bluestem. | Sideoats grama. | Western ragweed. |
| Indiangrass. | Blue grama. | Sand dropseed. |
| Little bluestem. | Buffalograss. | |
| Canada wildrye. | | |

Generally, this site is in fair condition, and western wheatgrass, blue grama, and buffalograss provide most of the forage. If moisture is favorable, sunflower, cocklebur, and other annual plants dominate on the site.

When this site is in excellent condition, its total annual production ranges from 4,000 to 6,000 pounds of air-dry herbage per acre.

#### LOAMY UPLAND RANGE SITE

This site consists of deep soils that have a loam to clay loam surface layer. Intake of water is moderate to slow, but water-holding capacity is high.

Decreasers make up at least 40 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers may amount to as much as 60 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Big bluestem. | Blue grama. | Little barley. |
| Switchgrass. | Buffalograss. | Annual brome. |
| Little bluestem. | Silver bluestem. | Common pricklypear. |
| Sideoats grama. | | |

Generally, this site is in fair condition, and blue grama and buffalograss provide most of the forage. In droughty years, common pricklypear is a noticeable invader.

When this site is in excellent condition, its total annual production ranges from 2,000 to 3,000 pounds of air-dry herbage per acre.

#### CLAY UPLAND RANGE SITE

This site consists of soils that occur in the uplands and have a silty clay loam surface layer over a silty clay subsoil. Penetration of the clayey subsoil by roots and water is difficult.

Decreasers make up at least 30 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers can amount to as much as 70 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Little bluestem. | Blue grama. | Little barley. |
| Switchgrass. | Buffalograss. | Annual brome. |
| Sideoats grama. | Silver bluestem. | Snow-on-the-mountain. |

Generally, this site is in fair condition, and buffalograss provides most of the forage. If moisture is favorable, silver bluestem may dominate on the site.

When this site is in excellent condition, its total annual production ranges from 1,000 to 2,500 pounds of air-dry herbage per acre.

#### LIMY UPLAND RANGE SITE

This site consists of deep, well-drained soils in the uplands. The subsoil of these soils contains much lime.

Decreasers make up at least 65 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers can amount to as much as 35 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Big bluestem. | Blue grama. | Common pricklypear. |
| Little bluestem. | Hairy grama. | Broom snakeweed. |
| Sideoats grama. | Buffalograss. | |
| | Sand dropseed. | |

Generally, this site is in fair range condition, and blue grama and buffalograss provide most of the forage. Broom snakeweed invades rapidly after years of severe drought.

When this site is in excellent condition, its total annual production ranges from 1,500 to 2,500 pounds of air-dry herbage per acre.

#### GRAVELLY HILLS RANGE SITE

This site consists of only one mapping unit, Gravelly broken land. This unit is gravelly and is generally shallow over sand and gravel. It takes in water very rapidly.

Decreasers make up at least 60 percent of the potential plant community, and other perennial grasses, forbs, and shrubs make up the rest. Increasers may amount to as much as 40 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Sand bluestem. | Blue grama. | Tumblegrass. |
| Little bluestem. | Hairy grama. | Windmillgrass. |
| Switchgrass. | Sand dropseed. | Three-awn. |
| Sideoats grama. | Sand sagebrush. | |

Generally, this site is in fair condition, and blue grama and hairy grama provide most of the forage.

When this site is in excellent condition, its total annual production ranges from 1,750 to 2,250 pounds of air-dry herbage per acre.

#### SANDY RANGE SITE

This site consists of deep soils that have a sandy loam surface layer and a sandy loam to clay loam subsoil. Intake of water is moderate to moderately slow. Where plant cover is removed, these soils blow.

Decreasers make up at least 55 percent of the potential plant community, and other perennial grasses, forbs, and shrubs make up the rest. Increasers may amount to as much as 45 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Sand bluestem. | Sideoats grama. | Three-awn. |
| Switchgrass. | Hairy grama. | Little barley. |
| Little bluestem. | Blue grama. | Windmillgrass. |
| | Buffalograss. | Sixweeks fescue. |
| | Sand dropseed. | Annual brome. |
| | Common pricklypear | Annual eriogonum. |
| | Small soapweed. | |

Generally, this site is in fair condition, and blue grama and buffalograss provide most of the forage. If moisture is favorable, sand dropseed and annual eriogonum may dominate on the site.

When this site is in excellent condition, its total annual production ranges from 2,000 to 3,000 pounds of air-dry herbage per acre.

#### SANDS RANGE SITE

This site consists of deep soils that range from loamy sand to sand in texture. Intake of water is moderately rapid to rapid, and much of the water taken in is retained and can be used by deep-rooted plants. Wind erosion is a major hazard.

Decreasers make up as much as 65 percent of the potential plant community, and other perennial grasses, forbs, and shrubs make up the rest. Increasers may

amount to as much as 45 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Sand bluestem. | Sand lovegrass. | Three-awn. |
| Little bluestem. | Sideoats grama. | False buffalograss. |
| Switchgrass. | Blue grama | Red lovegrass. |
| Big sandreed. | Hairy grama. | |
| | Sand dropseed. | |
| | Sand paspalum. | |
| | Sand sagebrush. | |

Generally, this site is in poor condition, and blue grama, sand dropseed, and sand paspalum provide most of the forage. Sand dropseed and sand sagebrush may dominate on the site.

When this site is in excellent condition, its total annual production ranges from 2,500 to 3,000 pounds of air-dry herbage per acre.

#### CHOPPY SANDS RANGE SITE

This site consists of areas of deep, loose sand. Intake of water is rapid, and much of the water taken in is retained and can be used by deep-rooted plants. When this site is in poor condition through overuse, it is highly susceptible to wind erosion.

Decreasers make up as much as 70 percent of the potential plant community, and other perennial grasses, forbs, and shrubs make up the rest. Increasers may amount to as much as 30 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Sand bluestem. | Sand lovegrass. | False buffalograss. |
| Little bluestem. | Sand dropseed. | Red three-awn. |
| Big sandreed. | Sand paspalum. | Red lovegrass. |
| Switchgrass. | Sand sagebrush. | Tumble lovegrass. |
| | Hairy grama. | Sandbur. |
| | Fragrant sumac. | |
| | Chickasaw plum. | |

Generally, this site is in poor condition, and sand dropseed and sand paspalum provide most of the forage. During prolonged periods of drought, this site blows badly if it is not under a good cover of sand sagebrush.

When this site is in excellent condition, its total annual production ranges from 1,500 to 2,500 pounds of air-dry herbage per acre.

#### BREAKS RANGE SITE

This site consists of shallow and steep soils that have a clay loam to loam surface layer. These soils are underlain by hard or semihard caliche.

Decreasers make up as much as 65 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers may amount to as much as 35 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Big bluestem. | Sideoats grama. | Three-awn. |
| Little bluestem. | Hairy grama. | Little barley. |
| Indiangrass. | Broom snakeweed. | Woolly plantain. |
| Switchgrass. | Fragrant sumac. | |
| Canada wildrye. | | |

Generally, this site is in good condition, and sideoats grama provides most of the forage. When the site is overgrazed, broom snakeweed increases rapidly.

When this site is in excellent condition, its total annual production ranges from 1,500 to 2,000 pounds of air-dry herbage per acre.

#### LOAMY TERRACE RANGE SITE

This site consists of soils that formed in alluvium. These soils have a loam to silty clay loam surface layer and subsoil. They are nearly level to slightly sloping and occur on benches, terraces, or fans along streams, and in swales in the uplands. They receive water from higher soils, and they are flooded occasionally by streams. The soils on this site are only moderately permeable to water and roots, but they have high capacity to hold both water and plant nutrients.

Decreasers make up at least 50 percent of the potential plant community, and other perennial grasses and forbs make up the rest. Increasers may amount to as much as 50 percent. The common decreasers, increasers, and invaders are—

| *Decreasers* | *Increasers* | *Invaders* |
|---|---|---|
| Switchgrass. | Western wheatgrass. | Silver bluestem. |
| Big bluestem. | Blue grama. | Annual brome. |
| Little bluestem. | Buffalograss. | Little barley. |
| Sideoats grama. | Western ragweed. | Windmillgrass. |
| Canada wildrye. | Woolly verbena. | Tumblegrass. |

Generally, this site is in fair condition, and western wheatgrass and blue grama provide most of the forage. Under heavy grazing, western wheatgrass in the main increaser.

This site produces more herbage than the Loamy Upland range site, but less than the Loamy Lowland range site. When the Loamy Terrace range site is in excellent condition, its total annual production of air-dry herbage ranges from 3,000 to 5,000 pounds per acre.

### *Principles of range management*

The management of rangeland in Gray County is directed mainly toward the production of beef cattle, for they are the most plentiful kind of livestock. Also, beef cattle are best suited to the rangeland in the county because they graze over a large area, generally make efficient use of the available forage, and protect themselves against predators. The practices used to manage rangeland for cattle, however, generally apply to other kinds of livestock.

Most important in good range management is proper range use, or good grazing practices. By adjusting the grazing throughout the year so that at least half of the growth of desirable grass remains on the range, the range operator can gradually improve the forage in quality and quantity and also protect the soils.

The forage plants preferred by livestock may differ at different seasons. For example, buffalograss, blue grama, and other grasses grow best during the warm season (May to October), and during this period are preferred by livestock to western wheatgrass. Western wheatgrass grows mainly during the cool season (October to December and March to May), and during these periods is preferred to buffalograss and blue grama.

Cattle wintering on range require supplemental food because in winter the grasses do not contain enough protein and minerals. This lack can be met by feeding a complete mineral salt and a protein concentrate of meal or pellets. Hay or silage will provide part of the mineral and protein needed and will provide roughage as well. Hay or silage should be stored for use in emergency when the range is covered by snow or is damaged by drought.

The range must be grazed uniformly if livestock are to make efficient use of the available forage and not damage

the range by overgrazing in the most desirable places and neglecting others. Grazing in areas that cattle normally neglect can be insured by carefully locating fences, watering places, salting places, and supplemental feeding stations. Much care should be taken in locating fences (fig. 9) and watering places, for these locations are permanent on most ranges. Salting and feeding stations are more flexible and from time to time can be moved to areas of the range that have not been recently grazed.

## Windbreak Management [4]

Gray County has no native forests or large areas of woodland, but small local areas on the flood plain along the Arkansas River support mixed stands of cottonwood, tamarisk, and other trees and shrubs. Since trees and shrubs survive only in those places that receive water in addition to rainfall, they are planted only for farmstead windbreaks, for shade, or for ornamental purposes.

If trees are to survive on the prairie soils of Gray County, they must be planted and managed in much the same way as field crops. The trees are planted in rows and are cultivated to keep out weeds and grass. Insects, diseases, and rodents must be controlled, and the plantings must be protected from fire and from grazing. All available water should be conserved or diverted into the planted area to promote growth. If these practices are followed, windbreak plantings can be successfully established, and their rate of growth and lifespan can be increased.

[4] Prepared by F. D. ABBOTT, soil conservationist, Soil Conservation Service.

### *Windbreak suitability groups*

The soils of Gray County have been placed in five windbreak groups according to their suitability for trees and shrubs. These five groups are Loamy Lowland, Loamy Upland, Sandy Upland, Subirrigated Loamy Lowland, and Clayey Upland. Three of these groups are in uplands. The Sandy Upland group consists of well-drained, nearly level to hummocky, sandy soils; the Loamy Upland group, of well-drained, nearly level to steep, loamy soils; and the Clayey Upland group, of well-drained, nearly level to gently sloping, clayey soils. Two groups are in lowlands. The Loamy Lowland group consists of well-drained, nearly level, loamy soils, and the Subirrigated Loamy Lowland group consists of nearly level, subirrigated, loamy soils. Each windbreak group is made up of soils that are suitable for about the same kinds of trees and shrubs, that require similar management, and that provide about the same chance of survival and rate of growth. The soils in each group are listed in the "Guide to Mapping Units" at the back of this survey and are described in the section "Descriptions of the Soils."

The suitability of the soils in each group is rated in table 4 for specified trees and shrubs. The ratings are *excellent*, *good*, *fair*, and *poor*.

## Wildlife Management [5]

The kinds and numbers of wildlife that can be produced in Gray County and elsewhere are determined mainly by the kind, amount, and distribution of the vegetation on

[5] By CHARLES V. BOHART, biologist, Soil Conservation Service.

**Figure 9.—A fence separates areas on the Sands range site so that grazing is more uniform.**

TABLE 4.—*Ratings of windbreak suitability groups for specified trees and shrubs*

[Based on rate of growth and chance of survival]

| Trees and shrubs | Windbreak suitability groups: Loamy Lowland | Loamy Upland | Sandy Upland | Subirrigated Loamy Lowland | Clayey Upland |
|---|---|---|---|---|---|
| Coniferous trees: | | | | | |
| Austrian pine | Excellent | Excellent | Excellent | Excellent | Excellent. |
| Eastern redcedar | Excellent | Excellent | Excellent | Excellent | Excellent. |
| Ponderosa pine | Excellent | Excellent | Excellent | Excellent | Excellent. |
| Shrubs: | | | | | |
| American wild plum | Good | Poor | Fair | Good | Poor. |
| Skunkbush | Good | Fair | Fair | Good | Poor. |
| Tamarisk | Good | Good | Fair | Excellent | Good. |
| Western chokecherry | Good | Poor | Good | Good | Poor. |
| Deciduous trees: | | | | | |
| American elm | Good | Poor | Poor | Poor | Poor. |
| Black walnut | Good | Poor | Poor | Poor | Poor. |
| Bur oak | Excellent | Good | Poor | Fair | Good. |
| Cottonwood | Excellent | Poor | Poor | Fair | Poor. |
| Green ash | Good | Poor | Poor | Poor | Poor. |
| Hackberry | Excellent | Fair | Fair | Fair | Poor. |
| Honeylocust (thornless) | Good | Good | Good | Fair | Poor. |
| Osage-orange | Excellent | Good | Excellent | Good | Fair. |
| Russian-olive | Good | Poor | Poor | Fair | Poor. |
| Russian mulberry | Fair | Fair | Poor | Poor | Poor. |
| Siberian elm | Good | Good | Good | Fair | Good. |

the soils. Fertile soils produce more vegetation, and therefore more wildlife, than less fertile soils. Also, water that has drained from fertile soils generally produce more fish than water from infertile soils.

The use of land for farming is helpful to wildlife, for food of high quality and some cover are produced. Properly used pastures and range benefit many wildlife species.

Topography affects wildlife mainly through its influence on land use. Rough, irregularly shaped areas may be a hazard to livestock and may be difficult to fence or to farm. Protecting and leaving undisturbed the vegetation in these areas are valuable practices in managing wildlife. In many places, where suitable plant cover is lacking, it can be developed to improve the habitat for desirable kinds of wildlife.

Wetness and the water-holding capacity of soils are important in the constructing of ponds for fish and in maintaining habitats for waterfowl. Soils that have a high water table are generally suitable for developing aquatic and semiaquatic habitats that can be used by waterfowl and by some species of furbearing animals.

The potential of each soil association in the county for producing food and cover for important kinds of wildlife is rated in table 5. The section "General Soil Map" tells something about the soils in each association, and the section "Descriptions of the Soils" gives more information. The general soil map at the back of this survey shows the location of each association in the county.

The soils of Gray County provide suitable habitats for many kinds of wildlife. Ring-necked pheasants are probably the most important game birds in the county, but bobwhite (quail) often inhabit areas along the Arkansas River, and a few prairie chickens have been reported in the Pratt-Tivoli soil association. Prairie chickens would benefit if the range in this association were kept in good or excellent condition.

Many kinds of waterfowl and other birds pass through the county in their semiannual migrations. The waterfowl use the water-filled depressions in the Spearville-Richfield and the Spearville-Harney soil associations. Other suitable depressions in these associations could be developed to increase the number of migratory waterfowl. Mourning doves, though not waterfowl, are important migrants. Deer often browse on the flood plain of the Arkansas River.

Channel catfish is the most important species of game fish in the Arkansas River. Suitable farm ponds are stocked with largemouthed black bass, bluegill, and channel catfish. Irrigation wells and waste water from irrigation can be used in filling fish ponds on suitable sites (fig. 10).

The wildlife in Gray County provides hunting, fishing, and other recreation and enhances picnicking, hiking, and photography. Many areas of land and water habitat could be improved so as to increase the wildlife and encourage more recreational activity. Improvement would benefit the landowners, as well as the people who took advantage of the increased opportunities.

In addition to the recreational opportunities, wildlife helps control undesirable insects and rodents. Hawks are especially valuable in controlling rodents.

In planning habitat for wildlife, assistance in selecting plants for specified kinds of soils, as well as assistance in engineering, can be obtained through the local office of the Soil Conservation Service. Additional information can be obtained from the Kansas Forestry, Fish and Game Commission and from the Extension Service.

*Figure 10.*—This natural depression has been filled with waste water from irrigation and stocked with fish. The soil is Randall clay.

## Engineering Uses of Soils [6]

This subsection gives brief descriptions of the systems of engineering soil classification, estimates of engineering properties of soils, ratings of suitability for soils used as construction material, and specific soil characteristics that affect the use of soils in engineering structures and practices.

Soil properties frequently influence design, construction, and maintenance of engineering structures. The properties most important are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Depth to water table, depth to bedrock, and topography are also important.

With the soil map for identification, the engineering interpretations reported here can be used for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works that involve heavy loads or where the excavations are deeper than the depth of layers here reported. Even in these situations, however, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

[6] Fred Meyer, Jr., civil engineer, Soil Conservation Service, assisted in the preparation of this subsection.

The information in this survey can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in the planning of agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversion terraces, irrigation canals, and irrigation systems.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations at the selected location.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in maintaining the structures. The information may also prove useful as a guide in future planning.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.

TABLE 5.—*Potential of soil associations for producing food and cover for the more important kinds of wildlife*

| Soil association | Wildlife | Potential for producing, for species of wildlife named— Woody cover | Herbaceous cover | Aquatic environment | Food |
|---|---|---|---|---|---|
| Spearville-Harney | Pheasant | | Good | | Good. |
| | Cottontail | | Fair | | Fair. |
| | Dove | | Good | | Good. |
| | Waterfowl | | | Good | Good. |
| Spearville-Richfield | Pheasant | | Good | | Good. |
| | Cottontail | | Fair | | Fair. |
| | Dove | | Good | | Good. |
| | Waterfowl | | | Good | Good. |
| Mansic-Ulysses | Cottontail | | Fair | Fair | |
| | Dove | | Fair | Fair | |
| Las Animas-Leshara-Lesho | Pheasant | Fair | Good | Fair | |
| | Quail | Good | Very good | Good | |
| | Dove | Good | Very good | Good | |
| | Cottontail | Good | Very good | Good | |
| | Deer | Good | Very good | Good | |
| | Waterfowl | | | Fair | Fair. |
| | Fish | | | | Good. |
| | Furbearers | Good | Good | Good | Good. |
| | Squirrel | Fair | | Fair | |
| Pratt-Tivoli | Prairie chicken | Fair | Good | Fair | |
| | Dove | Fair | Good | Fair | |
| | Deer | Fair | Good | Fair | |
| Richfield-Ulysses-Mansic | Pheasant | Fair | Good | Good | |
| | Dove | Fair | Good | Good | |
| | Cottontail | Fair | Fair | Fair | |
| | Fish | | | | Fair. |
| | Quail | Fair | Good | Good | |
| Manter-Satanta | Pheasant | Fair | Good | Fair | |
| | Dove | Fair | Good | Good | |
| | Prairie chicken | Fair | | Fair | |

8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Although the detailed soil map and the tables serve as a guide for evaluating most soils, a detailed investigation at the site of the proposed construction is needed because as much as 15 percent of an area designated as a specific soil on the map may consist of areas of other soils too small to be shown on the published map. By comparing the soil description with the result of investigations at the site, the presence of an included soil can usually be determined.

Some of the terms used by the soil scientists may not be familiar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

### Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture (*12*).[7] This system is useful only as the initial step for making engineering classifications of soils. The engineering properities of a soil must be determined or estimated after the textural classification have been made. Two systems are used by engineers for classifying soils. These are the systems used by the American Association of State Highway Officials (AASHO) (*1*) and the Unified system developed by the Corps of Engineers, U.S. Army (*17*). These systems are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Soil Primer (*9*).

*AASHO Classification System.*—The AASHO system of classifying soils is based on actual performance of material when used as a base for roads and highways. In this system soil materials are classified in seven basic groups. The materials most suitable for road subgrade are classed A–1, and those least suitable are classed A–7. Within fairly broad limits, all soil materials are classified numerically between these two extremes, according to their load-carrying ability. Three of the seven basic groups may be further divided into subgroups to designate variations within a group

In the ASSHO system, the soil materials may be placed in the following general groups: (1) Granular materials, in which 35 percent or less passes a No. 200 sieve; and (2) silt-clay materials, in which more than 35 percent passes a No. 200 sieve. The silty part of the silt-clay material has a plasticity index of 10 or less, and the

[7] Italic numbers in parenthesis refer to Literature Cited, page 57.

clayey material has a plasticity index greater than 10. The plasticity index is the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed in percentage of the ovendry weight, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed in percentage of the ovendry weight, at which the soil material passes from a semisolid to a plastic state.

*Unified Classification System.*—In the Unified system the soils are grouped on the basis of their texture and plasticity, as well as on their performance when used in engineering structures. The soil materials are identified as coarse grained, gravel (G) and sand (S); fine grained, silt (M) and clay (C); and highly organic (Pt). No highly organic soils were mapped in Gray County.

Under the Unified system, clean sands are identified by the symbols SW or SP; sand with fines of silt and clay are identified by the symbols SM and SC; silt and clay that have a low liquid limit are identified by the symbols ML and CL; and silt and clay that have a high liquid limit are identified by the symbols MH and CH.

On the basis of visual field inspection, an engineer can make an approximate classification of soils in the field. For exact classification, complete analysis of laboratory data is needed. Field classifications are useful for planning more detailed analyses at the site of construction.

### Engineering properties of the soils

Table 6 gives the estimated U.S. Department of Agriculture textural classification and the AASHO and Unified engineering classifications of the soils in the county. In addition, grain-size percentages, permeability, available water capacity, and shrink-swell potential are estimated.

The estimates in table 6 are for important horizons in a typical soil profile. They are based on the results of tests on similar soils in Ford (*15*), Logan, and Morton Counties, Kansas; on tests made by the State Highway Commission; and on information in other sections of the survey, particularly the section "Descriptions of the Soils."

Depth to the water table is not given in table 6. Throughout the valley of the Arkansas River the water table fluctuates. Depth to the water table ranges from 25 to about 70 feet in sandy areas of the upland, and from 50 to 150 feet in the High Plains and in areas of the upland that are not sandy. The amount of water available varies according to difference in the geologic formations and to the position of the soils.

A column in table 6 gives depth from the surface, but the kind of underlying material is not listed. Within 10 feet of the surface, the only kinds of rock are outcrops of caliche and sand and gravel of the Ogallala formation. The caliche crops out in areas of Potter soils of the Mansker-Potter complex. These areas are mainly in the sloping to moderately steep areas north of the Arkansas River. Additional information about the underlying material is given in the section "Formation and Classification of Soils."

The column that shows permeability gives the estimated rate, in inches per hour, that water moves through a saturated soil under the force of gravity and a one-half inch head of water.

Available water capacity, in inches per inch of soil depth, refers to the approximate amount of capillary water in the soil when it is wet to field capacity. When the soil is at the wilting point of common crops, this amount of water will wet the soil material to a depth of 1 inch without deeper penetration.

The rating for shrink-swell potential indicates the volume change to be expected when the moisture content changes. Randall soils have a high shrink-swell potential. They shrink greatly when they dry, and they swell when they are wet. Tivoli soils, on the other hand, have low shrink-swell potential. A knowledge of the shrink-swell potential is important in planning for the use of soil material in roads and other engineering structures.

The ratings of shrink-swell potential are based on the liquid limit of the soil. The shrink-swell potential of the soils in Gray County is indicated by the ratings of *low*, *moderate*, and *high*. The soils that have a liquid limit of 24 or less are rated low; those that have a liquid limit of 25 to 40 are rated moderate; and those that have a liquid limit of more than 40 are rated high.

The reaction of soils is not shown in table 6, because most of the soils in the county are neutral to moderately alkaline. Also, salinity is not shown because only the Las Animas, Leshara, and Lesho soils contain soluble salts and are slightly to moderately saline. The soils in the mapping unit, Las Animas-Lesho complex, alkali, are slightly to severely saline-alkali.

### Engineering interpretation of the soils

In table 7 ratings are given for the suitability of the soils as sources of topsoil, sand, gravel, road fill, and subgrade material. Also listed in table 7 are specific properties that affect the use of the soils in engineering structures and practices. These properties may affect the selection of a site, and they may affect the design of a structure or the application of measures to make the soil suitable for construction. Several land types are not listed in table 7, because their properties are variable and an investigation must be made at the site of each project.

The suitability of the soils as a source of topsoil is indicated in table 7 by a rating of *good*, *fair*, *poor*, or *not suitable*. These ratings are important because topsoil is needed for growing plants that control erosion on embankments, on the slopes along roads, and on cut slopes. Soil material from some part of the profile can be used as topsoil in many areas. Slopes cut in silty soils generally can be seeded without adding a layer of topsoil. Without topsoil, however, the cut slopes on Tivoli and other sandy soils are not suitable for seeding.

Also rated in table 7 is the suitability of the soils as a source of sand and gravel. Sand and gravel, in quantities suitable for use, occur as local pockets in the Las Animas soils, Pratt-Tivoli loamy fine sands, and Pratt loamy fine sand, gravel substratum. Many pockets of sand and gravel are at or near the surface along the old, meandering stream channels throughout the valley of the Arkansas River and along the channel of intermittent streams in the uplands. The Tivoli soils provide a dependable source of fine quartz sand.

The suitability of soils for road fill and road subgrade is given in table 7 for soil material that is excavated from borrow pits and used for highway subgrade. The

properties considered in determining these ratings are workability, shrink-swell potential, and compaction characteristics.

Some soils have impounded surface water that affects the location of highways. For example, the Lofton and Randall soils, which occur in depressions, have very slow permeability and poor surface drainage, and are subject to ponding during periods of heavy rainfall. Roads across these soils must be constructed on embankments, and sufficient subdrains must be provided. Also, there is a problem of flooding on the Leshara, Lesho, Las Animas, Lincoln, and Sweetwater soils in the valley of the Arkansas River. These soils have a fluctuating water table that is generally near the surface. Las Animas sandy loam, Manter fine sandy loam, Pratt loamy fine sand, Sweetwater soils, and Tivoli fine sand are subject to severe wind erosion where plant cover is removed.

Dikes or levees can be constructed on soils such as Las Animas sandy loam, Las Animas soils, Sweetwater soils, Lesho clay loam, and Lincoln soils. These soils have fair to good compaction characteristics, and they are suitable for use as construction materials in dikes and levees. The Lincoln and Sweetwater soils are permeable and have a fluctuating water table that is often near the surface. Because the soil material is variable, a detailed investigation of these soils at the site is needed. The Bridgeport and Dale soils are well drained, have good compaction characteristics, and can be used as construction materials.

Dale and Bridgeport soils are generally not used for reservoir areas or for embankments. These soils are in valleys or are in shallow drainageways. Ulysses-Colby silt loams and Mansic clay loam generally have slopes adjacent to areas that are suitable for reservoirs or embankments. In places, however, the Mansker-Potter complex of soils is unsuitable as a site for a farm pond because of the stratified sand and gravel or pockets of sand in the bottom of the drainage channel.

Agricultural drainage is affected by a high water table and by the location of the soils on the landscape. Leshara clay loam, Lesho clay loam, Las Animas sandy loam, Sweetwater soils, and Las Animas soils are difficult to drain because they have a seasonally high water table. Randall clay and Lofton silty clay loam are in upland depressions where outlets are few, or drainage is difficult because the areas are flat.

Soil features that affect the suitability of a soil for irrigation are shown in table 7. The suitability of soils for irrigation, and problems and limitations that affect irrigation, are also discussed in the subsection "Management of Irrigated Soils by Capability Units."

Field terraces and diversion terraces normally are not constructed on Dale silt loam and Bridgeport silty clay loam, which are level or nearly level soils in stream valleys. Because of the slopes and the hazard of wind erosion, terraces are not constructed on Pratt-Tivoli loamy fine sands and Manter fine sandy loam, undulating, eroded. All other soils in the county that are suitable for farming are suitable for terraces.

Some soils in the county are suitable for waterways. Where a waterway must be constructed through an area of Las Animas, Leshara, Lesho, Lincoln, or Sweetwater soils, it is necessary to make a detailed field investigation of the material that will be exposed in cuts. Soils such as the Las Animas, Lincoln, and Sweetwater need a covering of topsoil on exposed cuts so that vegetation will grow quickly and protect the soil from erosion.

# *Formation and Classification of Soils*

This section consists of two main parts. The first part tells how the factors of soil formation affected the formation of soils in Gray County. In the second part the system of soil classification currently used is explained, and each soil series in the county is placed in classes of this system and in the great soil group and soil order of the system adapted in 1938.

## Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or altered by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body having genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and in extreme cases may determine it almost entirely Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for soil horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are not well known.

### *Parent material*

The material from which the soils of Gray County developed belongs to three geologic systems. The youngest is the Quaternary, the second youngest is the Tertiary, and the oldest is the Cretaceous. Loess, dune sand, and alluvium are of the Quaternary period; outwash sediments are of the late Tertiary or early Quaternary; and the Greenhorn limestone formation is of the Cretaceous period.

Figure 11 (p. 50) shows a geologic cross section through the central part of the county from south to north (*8*). It also shows the general landscape in which many soils in the county occur.

Rocks of the Cretaceous period underlie Gray County, but only those of the Greenhorn limestone formation are exposed. This formation has not influenced the development and classification of soils in the county, except in small, isolated areas.

During the Tertiary period the Rocky Mountains were formed and when they began to erode, clay, silt, sand, and

TABLE 6.—*Estimated physical*

[Alluvial land (An), Blown-out land (Bo), Gravelly broken land (Gr), Las Animas soils

| Soil series and map symbols | Depth from surface | Classification | | |
|---|---|---|---|---|
| | | USDA texture | Unified | AASHO |
| | *Inches* | | | |
| Bridgeport (Bc, Bd). | 0–6 | Clay loam | CL | A–6 |
| | 6–60 | Silty clay loam | CL | A–6 or A–7 |
| Colby (Um). (For properties of Ulysses soil in mapping unit Um, refer to the Ulysses soil series.) | 0–60 | Silt loam | ML or CL | A–4 or A–6 |
| Dale (Da). | 0–25 | Silt loam | ML or CL | A–4 or A–6 |
| | 25–40 | Silty clay loam | CL | A–6 |
| | 40–60 | Silt loam | ML | A–4 |
| Harney (Ha). | 0–9 | Silt loam | ML or CL | A–4 or A–6 |
| | 9–14 | Silty clay loam | CL | A–6 or A–7 |
| | 14–25 | Silty clay | CL or CH | A–7 |
| | 25–39 | Silty clay loam | CL | A–6 or A–7 |
| | 39–60 | Silt loam | ML or CL | A–4 or A–6 |
| Las Animas (Ld, La). (For properties of the Lesho soil in mapping unit La, refer to the Lesho soil series.) | 0–11 | Sandy loam | SM | A–4 |
| | 11–30 | Fine sandy loam | SM | A–4 |
| | 30 | Coarse sand | SP-SM or SM | A–1 or A–2 |
| Leshara (Le). | 0–50 | Clay loam | CL | A–6 |
| | 50 | Coarse sand | SP-SM or SM | A–1 or A–2 |
| Lesho (Lh, Lk). (For properties of the Sweetwater soil in mapping unit Lk, refer to the Sweetwater soil series.) | 0–30 | Clay loam | CL | A–6 |
| | 30 | Coarse sand | SP-SM or SM | A–1 or A–2 |
| Lofton (Lo). | 0–6 | Silty clay loam | CL | A–6 |
| | 6–30 | Silty clay | CL | A–6 or A–7 |
| | 30–36 | Silty clay loam | CL | A–6 or A–7 |
| | 36–60 | Silt loam | CL | A–6 |
| Lubbock (Lu). | 0–15 | Loam | ML or CL | A–4 or A–6 |
| | 15–60 | Clay loam | CL | A–6 |
| Mansic (Md, Me, Mf, Mh). | 0–50 | Clay loam | CL | A–6 |
| Mansker (Mp). (For properties of the Potter soil in mapping unit Mp, refer to the Potter soil series.) | 0–19 | Loam | ML | A–4 |
| | 19–45 | Loam (caliche) | ML | A–4 |
| Manter (Mm, Mn, Mo, Mu). (For properties of the Ulysses soil in mapping unit Mu, refer to the Ulysses soil series.) | 0–40 | Fine sandy loam | SM, CL | A–4 |
| | 40–60 | Loam | CL | A–6 |
| Potter (Mp). | 0–8 | Clay loam | ML | A–4 |
| | 8 | Caliche | ML | A–4 |
| Pratt: | | | | |
| Loamy fine sand, undulating (Pa, Pt). (Properties of Tivoli soils in mapping unit Pt are variable and are not estimated.) | 0–11 | Loamy fine sand | SM | A–2 |
| | 11–26 | Fine sandy loam | SM | A–4 |
| | 26–60 | Loamy fine sand | SM | A–2 |
| Loamy fine sand, gravel substratum (Pg). | 0–36 | Loamy fine sand | SM | A–2 |
| | 36 | Coarse sand and gravel. | SP-SM or SM | A–1 or A–2 |
| Randall (Ra). | 0–8 | Silty clay | CH | A–7 |
| | 8–30 | Clay | CH | A–7 |
| | 30–60 | Silt loam | CL | A–6 |
| Richfield (Rm, Rn, Ro, Rs). (For properties of the Spearville soil in mapping unit Rs, refer to the Spearville soil series.) | 0–6 | Silt loam | CL | A–6 |
| | 6–23 | Silty clay loam | CL | A–6 or A–7 |
| | 23–60 | Silt loam | ML or CL | A–4 or A–6 |
| Satanta (Sa, Sb). | 0–18 | Loam | ML or CL | A–4 or A–6 |
| | 18–32 | Clay loam | CL | A–6 |
| | 32–60 | Silt loam | ML or CL | A–4 or A–6 |

*properties of soils*

(Lc), and Lincoln soils (Ll) are so variable that their properties were not estimated]

| Percentage passing sieve— | | | Permeability | Available water capacity | Shrink-swell potential |
|---|---|---|---|---|---|
| No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 200 (0.074 mm.) | | | |
| | | | *Inches per hour* | *Inches per inch of soil* | |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | 0. 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Low. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 20 | High. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 35 to 50 | 0. 5 to 1. 0 | . 15 | Low. |
| 100 | 100 | 40 to 50 | 0. 5 to 1. 0 | . 15 | Low. |
| 100 | 100 | 10 to 20 | 5. 0+ | . 04 | Low. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 10 to 20 | 5. 0+ | . 04 | Low. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 10 to 20 | 5. 0+ | . 04 | Low. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 20 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 60 to 75 | 0. 5 to 1. 0 | . 16 | Moderate. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 19 | Moderate. |
| 100 | 100 | 60 to 75 | 0.5 to 1.0 | . 16 | Low. |
| 100 | 100 | 60 to 75 | 0.2 to 0.5 | . 15 | Low. |
| 100 | 100 | 40 to 55 | 0.5 to 1.0 | . 15 | Low. |
| 100 | 100 | 60 to 75 | 0.5 to 1.0 | . 16 | Low. |
| 100 | 100 | 70 to 80 | 0.5 to 1.0 | . 18 | Low. |
| 100 | 100 | 70 to 80 | 0.2 to 0.5 | . 15 | Low. |
| 100 | 100 | 15 to 25 | 1.0 to 2.0 | . 10 | Low. |
| 100 | 100 | 35 to 50 | 0.5 to 1.0 | . 15 | Low. |
| 100 | 100 | 15 to 25 | 1.0 to 2.0 | . 10 | Low. |
| 100 | 100 | 15 to 25 | 1.0 to 2.0 | . 10 | Low. |
| 100 | 80 to 90 | 10 to 20 | 5. 0+ | . 04 | Low. |
| 100 | 100 | 90 to 95 | 0.05 to 0.2 | . 20 | High. |
| 100 | 100 | 75 to 95 | <0. 05 | . 21 | High. |
| 100 | 100 | 70 to 90 | 0.2 to 0.5 | . 18 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 60 to 75 | 0. 5 to 1. 0 | . 16 | Moderate. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |

| Soil series and map symbols | Depth from surface | Classification | | |
|---|---|---|---|---|
| | | USDA texture | Unified | AASHO |
| | *Inches* | | | |
| Spearville (Sp, Sr). | 0–7 | Silty clay loam | CL | A–6 |
| | 7–20 | Silty clay | CH | A–7 |
| | 20–26 | Silty clay loam | CL | A–6 or A–7 |
| | 26–60 | Silty loam | CL | A–6 |
| Sweetwater (Sw). | 0–5 | Clay loam | CL | A–6 |
| | 5–17 | Loam | ML or CL | A–4 or A–6 |
| | 17–26 | Fine sandy loam | SM or ML | A–4 |
| | 26 | Sand and gravel | SP–SM or SM | A–1 or A–2 |
| Tivoli (Tf). | 0–60 | Fine sand | SM | A–2 |
| Ulysses (Ua, Ub, Uc, Um). | 0–5 | Silt loam | ML or CL | A–4 or A–6 |
| | 5–14 | Silty clay loam | CL | A–6 |
| | 14–60 | Silt loam | ML | A–4 or A–6 |

TABLE 7.—*Engineering*

[Alluvial land (An), Blown-out land (Bo), and Gravelly broken land (Gr)

| Soil series and map symbols | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Road fill [1] | Subgrade [1] | Highway location |
| Bridgeport (Bc, Bd) | Good | Not suitable | Not suitable | Good | Fair | Good drainage; stable slopes. |
| Colby (Um) (For interpretations of Ulysses soils in mapping unit Um, refer to interpretations for the Ulysses series.) | Good | Not suitable | Not suitable | Good | Good | Good drainage; moderate erodibility. |
| Dale (Da) | Good | Not suitable | Not suitable | Good | Fair | Good drainage |
| Harney (Ha) | Good | Not suitable | Not suitable | Good | Poor | Good drainage |

See footnotes at end of table.

| Percentage passing sieve— No. 4 (4.7 mm.) | No. 10 (2.0 mm.) | No. 200 (0.074 mm.) | Permeability | Available water capacity | Shrink-swell potential |
|---|---|---|---|---|---|
| | | | *Inches per hour* | *Inches per inch of soil* | |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | 0. 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 20 | High. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 18 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 70 to 80 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 60 to 75 | 0. 2 to 0. 5 | . 16 | Moderate. |
| 100 | 100 | 40 to 55 | 0. 5 to 1. 0 | . 15 | Low. |
| 100 | 100 | 10 to 20 | 5. 0+ | . 04 | Low. |
| 100 | 100 | 10 to 20 | 2. 0 to 5. 0 | . 05 | Low. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Moderate. |
| 100 | 100 | 90 to 95 | 0. 05 to 0. 2 | . 19 | Moderate. |
| 100 | 100 | 70 to 90 | 0. 2 to 0. 5 | . 18 | Low. |

*interpretations of soils*

are so variable that interpretations for them were not made]

| Soil features affecting—Continued: Dikes and levees | Farm ponds: Reservoir area | Farm ponds: Embankment | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
|---|---|---|---|---|---|---|
| Fair to good compaction characteristics; stable slopes; moderately slow permeability. | Moderately slow permeability. | Fair to good compaction characteristics; stable slopes; impervious cores and blankets. | Good drainage; moderately slow permeability. | Thick soil material; good drainage; moderately slow permeability; high water-holding capacity. | Thick soil material; moderate erodibility. | Thick soil material; fertile; moderate erodibility; calcareous. |
| Moderate erodibility; low to moderate shear strength and stability. | Moderate permeabiity. | Moderate to low stability, shear strength, and plasticity; medium to high compressibility; fair compactibility. | Good drainage; moderate permeability. | Thick soil material; high water-holding capacity; moderate permeability. | Moderate erodibility. | Deep; friable; sloping; moderate erodibility. |
| Poor to fair compaction characteristics; moisture and compaction control needed. | Thick soil material; moderate permeability. | Poor to fair compaction characteristics; moisture and compaction control needed. | Good drainage; moderate permeability. | Thick soil material; good drainage; moderate permeability; high water-holding capacity. | Thick soil material; moderate erodibility. | Thick soil material; fertile; moderate erodibility. |
| Poor to fair compaction characteristics; moisture and compaction control needed. | Moderately slow permeability. | Poor to fair compaction characteristics; moisture and compaction control needed. | Good drainage; moderately slow permeability. | Thick soil material; good drainage; moderately slow permeability; high water-holding capacity. | Thick soil material; low erodibility. | Thick soil material; fertile; low erodibility. |

TABLE 7.—*Engineering interpretations*

| Soil series and map symbols | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Road fill [1] | Subgrade [1] | Highway location |
| Las Animas (La, Lc, Ld) (For interpretations of Lesho soils in mapping unit La, refer to interpretations for the Lesho series.) | Fair | Poor to good; shallow water table. | Poor; local pockets. | Good | Poor to good. | Shallow fluctuating water table; slight flooding hazard. |
| Leshara (Le) | Good | Poor to good; high fluctuating water table. | Fair | Fair | Poor to fair. | High fluctuating water table; slight flooding hazard. |
| Lesho (Lh, Lk) (For interpretations of the Sweetwater soils in mapping unit Lk, refer to interpretations for the Sweetwater series.) | Good | Poor to good; high fluctuating water table. | Fair | Fair | Poor to fair. | High fluctuating water table; slight flooding hazard. |
| Lincoln (Ll) | Not suitable | Good; poorly graded. | Poor; local pockets. | Fair to good. | Poor to good. | High water table; flooding hazard. |
| Lofton (Lo) | Poor | Poor | Poor | Poor | Poor | Depressional area; fills with storm runoff. |
| Lubbock (Lu) | Good | Not suitable | Not suitable | Good | Good | Good drainage |
| Mansic (Md, Me, Mf, Mh) | Good | Poor; local pockets. | Poor; local pockets. | Good | Fair | Good drainage |

See footnotes at end of table.

*of soils*—Continued

| Soil features affecting—Continued | | | | | | |
|---|---|---|---|---|---|---|
| Dikes and levees | Farm ponds | | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
| | Reservoir area | Embankment | | | | |
| Good compaction characteristics; high erodibility; probable underflow and sand boils. | Not applicable | Not applicable | Fluctuating water table. | Moderately rapid permeability; moderate water-holding capacity. | Not applicable | Not applicable. |
| Fair to good compaction characteristics; stable slopes; probable underflow and sand boils. | Not applicable | Not applicable | Seasonally high water table. | Moderately slow permeability; moderate water-holding capacity. | Not applicable | Not applicable. |
| Fair to good compaction characteristics; stable slopes; probable underflow and sand boils. | Not applicable | Not applicable | Seasonally high water table. | Moderately slow permeability; moderate water-holding capacity. | Not applicable | Not applicable. |
| Unstable | Not applicable | Not applicable | Frequent flooding; fluctuating water table; rapid permeability. | Not applicable | Not applicable | High erodibility; unstable banks; low fertility. |
| Fair to good compaction characteristics; moderate to high shrink-swell potential; moderate to low shear strength. | Slow permeability. | Fair to good compaction characteristics; moderate to high shrink-swell potential; moderate to low shear strength. | Depressional ponding; outlets remote; slow permeability. | Thick soil material; slow permeability; high water-holding capacity. | Thick soil material; low erodibility. | Thick soil material; fertile; low erodibility. |
| Fair to poor compaction characteristics; stable slopes. | Moderately slow permeability. | Fair to poor compaction characteristics; moderate shear strength; moderate to high shrink-swell potential. | Good drainage | Thick soil material; moderately slow permeability; high water-holding capacity. | Thick soil material; moderate erodibility. | Thick soil material; fertile; moderate erodibility. |
| Fair to good compaction characteristics; stable slopes. | Moderately slow permeability. | Fair to good compaction characteristics; stable slopes; impervious cores and blankets. | Good drainage; moderately slow permeability. | Thick soil material; moderately slow permeability; high water-holding capacity; slopes. | Thick soil material; moderate erodibility. | Highly calcareous. |

TABLE 7.—*Engineering interpretations*

| Soil series and map symbols | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Road fill [1] | Subgrade [1] | Highway location |
| Mansker (Mp) (For interpretations of the Potter soils in mapping unit Mp, refer to interpretations for the Potter series.) | Surface layer good; not suitable below a depth of 12 inches. | Not suitable | Good source of caliche below a depth of 30 inches. | Good | Poor | Caliche at a depth of 12 to 36 inches. |
| Manter (Mm, Mn, Mo, Mu) (For interpretations of Ulysses soils in mapping unit Mu, refer to interpretations for the Ulysses series.) | Fair | Poor | Poor | Good | Good | Good drainage |
| Potter (Mp) | Not suitable | Not suitable | Good source of caliche. | Good | Poor | Caliche at a depth of 12 inches or less. |
| Pratt (Pa, Pg, Pt) (For interpretations of Tivoli soils in mapping unit Pt, refer to interpretations for the Tivoli series.) | Not suitable | Fair; local pockets. | Fair; local pockets. | Good | Good | Good drainage |
| Randall (Ra) | Poor | Not suitable | Not suitable | Poor | Poor | Poor drainage; depressions fill from runoff. |
| Richfield (Rm, Rn, Ro, Rs) (For interpretations of the Spearville soils in mapping unit Rs, refer to interpretations for the Spearville series.) | Good | Not suitable | Not suitable | Fair to good. | Fair to poor. | Good drainage; stable slopes. |
| Satanta (Sa, Sb) | Good | Not suitable | Not suitable | Good | Good | Good drainage |

**See footnotes at end of table.**

*of soils*—Continued

| Soil features affecting—Continued | | | | | | |
|---|---|---|---|---|---|---|
| Dikes and levees | Farm ponds | | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
| | Reservoir area | Embankment | | | | |
| Moderate shear strength and stability. | Moderate permeability; caliche below a depth of 12 to 36 inches. | High compressibility; moderate stability, shrink-swell potential, shear strength, and permeability. | Good drainage | Not applicable | Not applicable | Moderately thin soil material; moderate stability; low erodibility. |
| Good compaction characteristics; high erodibility. | Moderate permeability. | Good compaction characteristics; high erodibility. | Good drainage; moderate permeability. | Thick soil material; moderate permeability; moderate water-holding capacity. | Thick soil material; high erodibility. | Thick soil material; high erodibility. |
| Not applicable | Shallow over caliche; some sand pockets. | Moderate shear strength, shrink-swell potential, stability, and plasticity; fair to good compaction. | Good drainage | Not applicable | Not applicable | Shallow over caliche; steep. |
| Good compaction characteristics; moisture control needed; unstable slopes; high erodibility. | Rapid permeability. | Good compaction characteristics; moisture control needed; unstable slopes; high erodibility. | Good drainage | Thick soil material; rapid permeability; moderate water-holding capacity. | Not applicable | Not applicable. |
| Fair to poor compaction characteristics; high shrink-swell potential; cracks when dry. | Very slow permeability. | Fair to poor compaction characteristics; low shear strength; high shrink-swell potential; cracks when dry. | Poor drainage; water stands in depressions. | Not applicable | Not applicable | Not applicable. |
| Fair to poor compaction characteristics; moderate shear strength and stability. | Moderately slow permeability. | Fair to poor compaction characteristics; stable slopes. | Good drainage; thick material. | Thick soil material; moderately slow permeability; high water-holding capacity; nearly level to gentle slopes. | Thick soil material; low erodibility. | Thick soil material; fertile; low erodibility. |
| Poor to fair compaction characteristics; stable slopes. | Moderate permeability. | Poor to fair compaction characteristics; stable slopes. | Good drainage; moderate permeability. | Thick soil material; moderate permeability; high water-holding capacity. | Thick soil material; moderate erodibility. | Thick soil material; fertile; moderate erodibility. |

TABLE 7.—*Engineering interpretations*

| Soil series and map symbols | Suitability as source of— | | | | | Soil features affecting— |
|---|---|---|---|---|---|---|
| | Topsoil | Sand | Gravel | Road fill [1] | Subgrade [1] | Highway location |
| Spearville (Sp, Sr) | Fair | Not suitable | Not suitable | Fair | Poor | Good drainage |
| Sweetwater (Sw) | Poor | Good below a depth of 15 inches. | Poor; local pockets. | Fair | Poor to fair. | High water table. |
| Tivoli (Tf) | Poor | Good | Poor | Good if confined. | Good if confined. | Good drainage; unstable slopes; high erodibility. |
| Ulysses (Ua, Ub, Uc, Um) | Good | Poor | Poor | Good | Good | Good drainage |

[1] Ratings estimated with the assistance of C. W. HACKETHORN, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, in cooperation with the U.S. Department of Commerce, Bureau of Public Roads.

gravel were carried into Gray County by the swift-flowing streams. This process continued into the Quaternary period, and deposits of these outwash sediments gradually built up to about the present height of the High Plains.

In the Quaternary period important geologic events in the county began late in the Pleistocene epoch and continued intermittently into the Recent epoch. Much of the present topography of the county is the result of erosion and other geologic changes and of climatic changes during this period. The sandhills south of the Arkansas River consist of fairly recent deposits. Dunes in the county were built largely by north winds that stripped sandy alluvium from the flood plain of the Arkansas River (*10*), and about the same time great duststorms deposited eolian material over much of the area. The most recent sedimentation has been in valleys where alluvium, consisting of silt, sand, and gravel, has been deposited in the channels and on the flood plains of streams (*8*).

The material from which the soils of Gray County developed consists mainly of (1) loess deposited in Pleistocene time, (2) outwash sediments of late Pliocene or of Pleistocene time, (3) eolian sand deposited in Pleistocene time, and (4) alluvium deposited in Recent time.

*Loessal deposits.*—Loessal deposits consist of almost grit-free material that was deposited by wind. This material was deposited during the Wisconsin stage of glaciation in Pleistocene time on the nearly level to gently sloping summit of the High Plains and generally ranges from about 10 to 30 feet in thickness. Spearville, Richfield, and Harney are the dominant soils that developed in loess.

*Outwash sediments.*—In the rolling erodible uplands, mainly in the east-central part of the county, are limy outwash sediments of the Pliocene and Pleistocene time. In places these sediments are of unconsolidated, stratified silt, sand, and gravel; in other places they are of weakly cemented, limy sand, silt, and clay. These deposits contain beds of caliche, which are exposed in places. The Potter is the only soil in the county developed wholly in outwash sediments, and in this county it is mapped only in a complex with Mansker soil. In erodible valleys below the summit of the High Plains, the loess is thin and wind has mixed much of it with the more sandy outwash materials. The Mansker and Mansic soils developed in these mixed materials.

*Eolian sand.*—Several soils have developed in eolian sand in a band that extends across the county south of

*of soils*—Continued

| Soil features affecting—Continued | | | | | | |
|---|---|---|---|---|---|---|
| Dikes and levees | Farm ponds | | Agricultural drainage | Irrigation | Terraces and diversions | Waterways |
| | Reservoir area | Embankment | | | | |
| Fair to poor compaction characteristics; high shrink-swell potential. | Moderately slow permeability. | Fair to poor compaction characteristics; fair stability on flat slopes; high shrink-swell potential. | Good drainage; slow permeability. | Thick soil material; slow permeability; high water-holding capacity; nearly level to gentle slopes. | Thick soil material; moderate erodibility; high shrink-swell potential. | Thick soil material; fertile; moderate erodibility. |
| Moderate shear strength and stability. | Not applicable | Not applicable | Poor drainage; fluctuating water table; drainage difficult to establish. | Not applicable | Not applicable | Sandy substratum allows seepage; saline. |
| Good compaction characteristics; moisture control needed; unstable slopes; high erodibility. | Excessive seepage. | Good compaction characteristics; moisture control needed; unstable slopes; high erodibility. | Good drainage | Not applicable | Not applicable | Not applicable. |
| Fair to poor compaction characteristics; stable slopes. | Moderate permeability. | Fair to poor compaction characteristics; moderate shear strength, stability, and plasticity. | Good drainage; moderate permeability. | Thick soil material; moderate permeability; high water-holding capacity. | Thick soil material; moderate erodibility. | Thick soil material; fertile; moderate erodibility. |

the Arkansas River. Deposition of this sand began in late Pleistocene time and continued into Recent time. The dunes and hummocks of this sand are steep and choppy near the river, but toward the south they gradually become less steep. Tivoli and Pratt soils dominate in this sandy material.

*Recent alluvium.*—The soils in Gray County that developed in alluvium are young. The alluvium ranges from clay to sand in texture and is lighter colored where it is silty and sandy. The Bridgeport and Dale soils, on the more stable deposits, have a more distinct profile than the Las Animas and Lincoln soils, on less stable deposits.

### Climate

Climate affects the physical, chemical, and biological relationship in the soil. The amount of water that percolates through the soils depends mainly on rainfall, humidity, and length of frost-free periods. Water dissolves small amounts of soil minerals and carries them out of the soil. Favorable temperature encourages the growth of organisms and hastens chemical reactions in the soil.

The continental climate of Gray County is typical of the climate in the High Plains. It is characterized by extremes of temperature in both summer and winter, by low relative humidity, and by slight to moderate, irregular rainfall.

Because the amount of precipitation in Gray County is small, soil minerals have not been weathered and leached to any great extent. Few soils have been leached of lime to a depth greater than 30 inches. Except for soils that formed in noncalcareous fine sand and some young soils that formed in alluvium, most soils in the county have an accumulation of calcium carbonate within a depth of 30 inches.

### Plant and animal life

Plant and animal life, both on and in the soil, are active in the soil-forming processes. The kinds of plants, animals, and micro-organisms that live in and on the soil are determined mainly by the other factors of soil formation—climate, parent material, relief, and age of the soil. Climate strongly influences the kind of plants and animal life and thereby exerts a strong, indirect influence on soil formation. As the plants and animals die and decay, organic material is added to the soil. Most of this material is added to the A horizon, where it is acted upon by

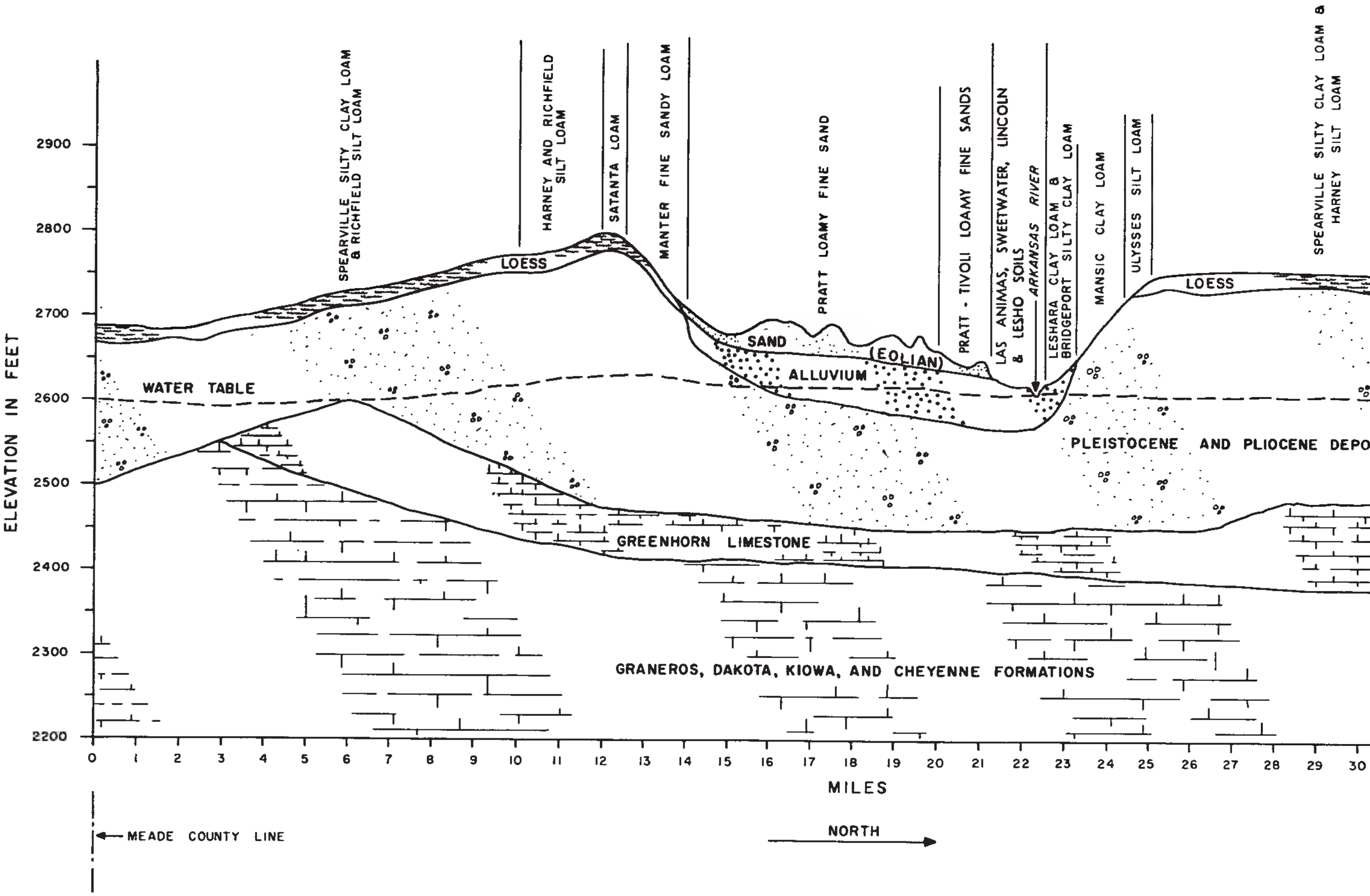


*Figure 11.*—**Approximate geologic cross section through the central part of Gray County and the general location of soils on th**

micro-organisms, earthworms, and other living forms and by chemicals that are in the soil and in the remains of plants and animals.

The soils of Gray County developed under grass. As a result, a typical soil profile in the county consists of dark-colored upper horizons that are rich in organic matter; a transitional horizon that, in many places, is slightly finer textured and somewhat lighter colored than the layer above; and underlying parent material that is generally light colored and rich in calcium carbonate.

### *Relief*

Relief, or the lay of the land, affects runoff and drainage. If plant cover, rainfall, and other factors are about equal, runoff is rapid from steep slopes and slower or lacking from nearly level areas. As a result, soil formation is less rapid in the more sloping areas.

For example, the parent material of the Randall, Richfield, and Ulysses soils is similar, and most of the differences in profile characteristics are the result of differences in relief. Randall soils are in undrained depressions that receive runoff from adjacent areas. The clayey texture and gray color of the Randall soils show the effects of additional moisture and poor drainage. Richfield soils have smooth, gentle slopes and have neither restricted nor excessive runoff. Of all the soils in the county, the Richfield most nearly reflect the full influence of climate on the parent material. The Ulysses soils are in sloping and convex areas. Runoff and erosion have been greater on these soils than on the less sloping soils, and their less distinct profile reflects the influence of relief.

### *Time*

Time is required for formation of soils. The length of time needed depends on the kind of parent material and the other factors of soil formation. If the soil-forming processes have not operated long enough for a soil to form that is in equilibrium with its environment, the soil is described as young or immature. In general, the mature soils are those that have reached equilibrium with their environment.

The soils of Gray County range from immature soils that have little or no profile development to mature soils that have thick, distinct profiles. The Tivoli soils in the sandhills are immature because they have been stabilized for only a short time. The hummocky, loose sand supports only a thin, sparse vegetation, and soil formation proceeds slowly.

The oldest soils in the county are some buried soils that occur in many parts of the uplands. Spearville, Harney, and Richfield soils have thick, distinct profiles and are mature soils.

## Classification of Soils

Soils are classified so that we may more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about soils can be organized and applied to farms, fields, and ranges; in engineering works; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils are now in general use in the United States. One of these is the 1938 system (*2*), with later revisions (*14*). The other, the current system, was placed in general use by the Soil Conservation Service in 1965. The reader who is particularly interested in the current system should search the literature (*13*, *11*). Modifications in the system are made as knowledge of the soils increases. In this survey the classes in the newer system and the orders and great soil groups of the older system are given for each soil series in table 8. The classes in the current system are briefly defined in the paragraphs that follow. Each soil mapped in the county is described in the section "Descriptions of the Soils."

ORDERS: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are generally those that tend to give broad climatic groupings of soils. Two exceptions are the Entisols and Histosols, which occur in many different climates. Table 8 shows the four soil orders in Gray County—Entisols, Vertisols, Mollisols, and Alfisols.

SUBORDERS: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or the soil differences resulting from the climate or vegetation.

GREAT GROUPS: Soil suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans interfering with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUPS: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Ustipsamment.

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils where used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability,

TABLE 8.—*Soil series classified according to the current system of classification and the 1938 system*

| Series | Current classification | | 1938 system | | |
|---|---|---|---|---|---|
| | Family | Subgroup | Order | Great soil group | Order |
| Bridgeport | Fine silty, mixed, mesic | Entic Haplustolls | Mollisols | Alluvial | Azonal. |
| Colby | Fine silty, mixed, calcareous, mesic | Typic Ustorthents | Entisols | Regosol | Azonal. |
| Dale | Fine silty, mixed, thermic | Typic Hapludolls | Mollisols | Alluvial intergrading toward Chernozem. | Azonal. |
| Harney | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols | Chernozem | Zonal. |
| Las Animas | Coarse loamy, mixed, calcareous, mesic. | Aquic Ustifluvents | Entisols | Alluvial | Azonal. |
| Leshara | Fine silty, mixed, mesic | Aquic-Fluventic Haplustolls. | Mollisols | Alluvial | Azonal. |
| Lesho | Fine silty, over sandy, mixed mesic | Aquic-Fluventic Haplustolls. | Mollisols | Alluvial | Azonal. |
| Lincoln | Sandy, mixed, nonacid, thermic | Typic Ustipsamments | Entisols | Alluvial | Azonal. |
| Lofton | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols | Chestnut | Zonal. |
| Lubbock | Fine, montmorillonitic, thermic | Cumulic Argiustolls | Mollisols | Chestnut | Zonal. |
| Mansic | Fine loamy, mixed, thermic | Typic Haplustolls | Mollisols | Chestnut intergrading toward Regosol. | Zonal. |
| Mansker | Fine loamy, mixed, thermic | Typic Calciustolls | Mollisols | Calcisol | Intrazonal. |
| Manter | Coarse loamy, mixed, mesic | Typic Haplustolls | Mollisols | Chestnut | Zonal. |
| Potter | Loamy, mixed, calcareous, thermic | Lithic Ustorthents | Entisols | Lithosol | Azonal. |
| Pratt | Sandy, siliceous, thermic | Psammentic-Udic Haplustalfs. | Alfisols | Reddish Chestnut | Zonal. |
| Randall | Montmorillonitic, thermic | Typic Pellusterts | Vertisols | Grumusol | Intrazonal. |
| Richfield | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols | Chestnut | Zonal. |
| Satanta | Fine loamy, mixed, mesic | Typic Argiustolls | Mollisols | Chestnut | Zonal. |
| Spearville | Fine, montmorillonitic, mesic | Typic Argiustolls | Mollisols | Chernozem | Zonal. |
| Sweetwater | Coarse loamy, mixed, thermic | Typic Haplaquolls | Mollisols | Humic Gley | Intrazonal. |
| Tivoli | Sandy, siliceous, nonacid, thermic | Typic Ustipsamments | Entisols | Regosol | Azonal. |
| Ulysses | Fine silty, mixed, mesic | Typic Haplustolls | Mollisols | Chestnut | Zonal. |

thickness of horizons, and consistence. An example of a family is the sandy, siliceous, nonacid, thermic family of Typic Ustipsamments.

A description of each soil mapped in the county can be found in the section "Descriptions of the Soils."

# General Nature of the County

In this section the history and development of the area, climate, agriculture, and other subjects of general interest are discussed. The statistics on agriculture and population are from the Census of Agriculture and Kansas State Board of Agriculture, Biennial Reports.

## History

The southern part of the present area of Gray County has been successively held by Spain, France, Mexico, Texas, and the United States. The famous Santa Fe Trail originally passed through the present towns of Cimarron, Ingalls, and Charleston, but by 1830 most of the traffic crossed the Arkansas River near the present site of Cimarron. Construction of the Atchison, Topeka and Santa Fe Railway early in the 1870's opened the area for settlement.

Gray County was organized in 1887. It was named for Alfred Gray, the first secretary of Kansas State Board of Agriculture.

The population of the county has fluctuated over the years. It has decreased rapidly during periods of prolonged drought but increased when there was enough rainfall to produce crops.

After the drought and duststorms of the 1930's, people in the county became concerned about soil erosion and land deterioration. In 1947, the farmers and landowners organized the Gray County Soil Conservation District to promote proper land use and the conservation of soil and water. Since the formation of the district, many acres of land not suitable for farming have been reseeded to native grasses, and terracing, contouring, stubble mulching, supplemental irrigation, and other practices have been used on many acres of cropland.

One of the first projects to protect soils downstream from flooding in Kansas was completed on a watershed in Gray County in 1961. The primary objective was flood prevention, but the water stored has many uses.

## Physiography, Relief, and Drainage

Gray County is in the High Plains section of the Great Plains physiographic province. Elevations range from about 2,900 feet above sea level in the northwest corner to about 2,550 feet in the southeastern part of the county. In general, most of the county consists of nearly level to gently sloping plains that are typical of the High Plains. The general features of the landscape in Gray County are shown in figure 12.

The upland plains on both sides of the Arkansas River are nearly level and have poorly defined drainage patterns. These plains are tablelands that slope gently eastward on a gradient of about 5 to 7.5 feet per mile. The area of uplands south of the Arkansas River is bordered on the north by the hummocky sandhills and on the south by the drainage basin of Crooked Creek. Areas of more steeply sloping land lie between the upland areas and the flood plains of the Arkansas River, of Crooked Creek, and of

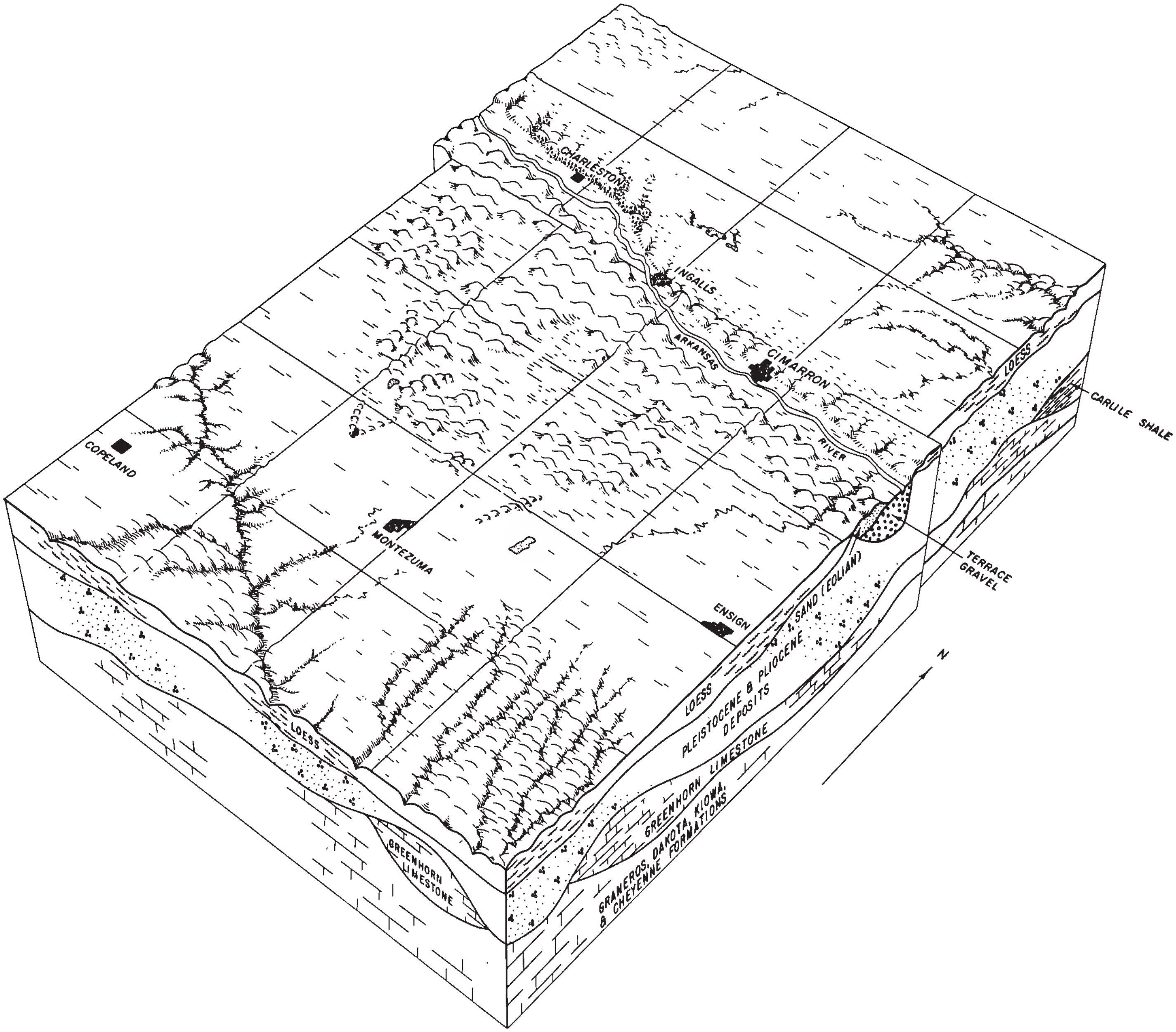


*Figure 12.*—**General landscape features and drainage patterns of Gray County.**

tributaries to these streams. The surface of these steeper areas is more dissected than the plains, and there are fewer nearly level areas. The steeper areas are adjacent to the intermittent streams in the uplands, and the more gently sloping areas are on the crest and sides of ridges between the drainageways.

A band of hummocky sandhills and dunes lies south of and adjacent to the flood plain of the Arkansas River. This band is about 2 to 4 miles wide and extends across the county, roughly parallel to the river.

The Arkansas River flows east-southeast across the northern one-third of the county, and Crooked Creek, an intermittent stream, crosses the southwestern part. The flood plain of the Arkansas River is nearly level and ranges from 1 to 1.5 miles in width. On the north is a fairly continuous line of low bluffs; on the south are the sandhills. Numerous intermittent streams empty into the river from the north, but only one short stream, which is in the extreme eastern part of the sandhills, empties into the river from the south.

## Climate [8]

The semiarid, continental climate of Gray County is characterized by abundant sunshine, low annual precipitation, and large variations in daily and annual temperature. The large variations in temperature are the result

[8] By Merle J. Brown, State climatologist, U.S. Weather Bureau, Manhattan, Kans.

of high altitude and low humidity, both of which allow marked heating by solar radiation during the day and large losses of heat from the ground at night.

The climate of Gray County is affected by the Rocky Mountains, which are about 275 miles to the west. Storms moving inland from the Pacific Ocean lose much of their moisture in crossing these north-south ranges. Because of this decrease in atmospheric moisture, together with the movement of storms downslope, little or none of the precipitation in the county is from Pacific weather systems. Moisture from the Gulf of Mexico is the principal source of precipitation (*7*).

Table 9 gives data about precipitation and temperature recorded at Cimarron, Kans., by the U.S. Weather Bureau.

Precipitation varies widely from year to year, but it is generally inadequate for optimum growth of most crops. In addition, the kinds of dryfarmed crops that can be grown successfully are limited because the average evapotranspiration is considerably higher than average precipitation. A common farm practice used to minimize this lack of moisture is summer fallowing.

The average annual rainfall ranges from about 19 inches along the western border of the county to 20 inches in the eastern part. Most of this rain falls during the growing season. The driest period of the year is from November through March, when the average precipitation in each month is less than 1 inch. On the average, three-fourths of the annual precipitation falls during the 6-month period extending from April through September. Rainfall decreases markedly through August and September, and occasionally soil moisture is inadequate for the planting of winter wheat and other fall-sown crops.

In periods when rainfall is heaviest, much of it comes in showers and thunderstorms. On the average, 50 to 60 days during each year has thunderstorms, a few accompanied by high winds, hail, and a heavy downpour of rain. In wetter years when other conditions are favorable for crops, losses from hail generally are the most severe (*5*), but the hail usually damages crops only in small local areas.

Figure 13 shows the probabilities, in percent, of receiving specified amounts of precipitation in a 7-day period

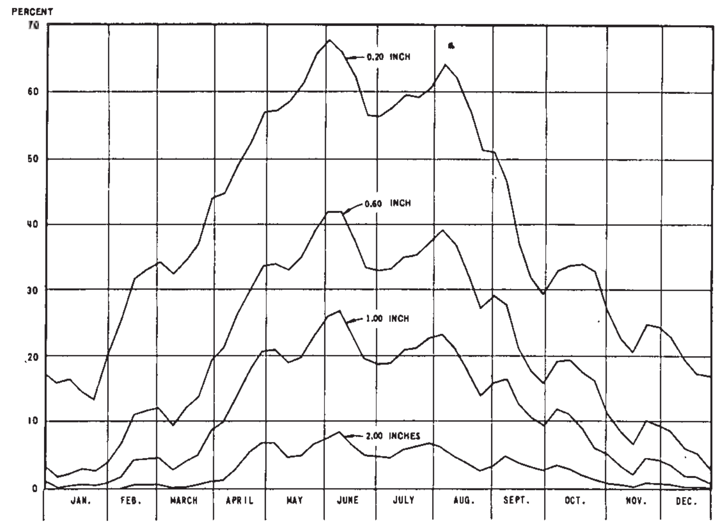


***Figure 13.*—Probabilities of receiving at least the indicated amount of precipitation weekly. Calculated from data recorded at Garden City, Kansas, for the period 1900 to 1960.**

TABLE 9.—*Temperature and precipitation*

[All data from Cimarron, Kans.]

| Month | Temperature | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|
| | Average daily maximum [1] | Average daily minimum [1] | Two years in 10 will have at least 4 days with—: Maximum temperature equal to or higher than [2]— | Two years in 10 will have at least 4 days with—: Minimum temperature equal to or lower than [2]— | Average monthly total [3] | One year in 10 will have—: Monthly total less than [1]— | One year in 10 will have—: Monthly total more than [1]— |
| | *° F.* | *° F.* | *° F.* | *° F.* | *Inches* | *Inches* | *Inches* |
| January | 44. 4 | 16. 2 | 65 | 0 | 0. 38 | ([4]) | 1. 00 |
| February | 49. 8 | 20. 9 | 70 | 5 | . 74 | 0. 07 | 1. 52 |
| March | 57. 6 | 27. 5 | 78 | 9 | . 92 | . 09 | 1. 73 |
| April | 69. 0 | 39. 5 | 87 | 25 | 1. 94 | . 18 | 3. 94 |
| May | 77. 2 | 50. 3 | 92 | 37 | 3. 11 | . 76 | 6. 41 |
| June | 87. 2 | 59. 9 | 102 | 48 | 3. 26 | . 90 | 6. 08 |
| July | 94. 0 | 65. 0 | 105 | 56 | 2. 91 | . 86 | 6. 96 |
| August | 92. 9 | 63. 5 | 105 | 55 | 2. 64 | . 58 | 5. 08 |
| September | 84. 3 | 54. 6 | 98 | 39 | 1. 92 | . 33 | 4. 10 |
| October | 72. 9 | 41. 9 | 89 | 28 | 1. 59 | . 12 | 4. 15 |
| November | 58. 0 | 27. 4 | 74 | 11 | . 84 | ([4]) | 1. 95 |
| December | 46. 6 | 19. 0 | 67 | 7 | . 52 | ([4]) | 1. 54 |
| Year | 69. 5 | 40. 2 | [5]103 | [6]−10 | 20. 77 | [7]13. 06 | [8]29. 05 |

[1] For the period 1912–1964.
[2] For the period 1936–1960.
[3] For the period 1906–1960.
[4] Trace.
[5] Average annual highest maximum.
[6] Average annual lowest minimum.
[7] Annual value equal to or less than.
[8] Annual value equal to or more than.

(*4*). The records are from Garden City, Kansas, but are considered fairly representative of conditions in Gray County. Information in figure 13 indicates that the best chances of receiving 0.20 inch or more of moisture are late in May or early in June and during the first week in August. Precipitation will decrease probably late in June and early in July, which is about the time winter wheat is harvested. Table 10 gives the frequency of rainfall of specified duration for return periods of 1 year, 2 years, 5 years, 10 years, 25 years, 50 years, and 100 years (*16*).

Snowfall is light in most years. The average for the county as a whole is about 20 inches annually, but it is slightly more in the northwestern part. Blizzards occur occasionally in winter, but they are infrequent. Blizzards and other snowstorms are usually of short duration; they rarely last more than 1 or 2 days. Snow usually does not remain on the ground very long.

TABLE 10.—*Frequency of specified amounts of rainfall during stated time intervals at Cimarron*

| Length of return period in years [1] | 30 min. | 1 hr. | 2 hrs. | 3 hrs. | 6 hrs. | 12 hrs. | 24 hrs. |
|---|---|---|---|---|---|---|---|
| | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| 1 | 0. 9 | 1. 2 | 1. 4 | 1. 4 | 1. 6 | 1. 8 | 2. 0 |
| 2 | 1. 2 | 1. 5 | 1. 7 | 1. 8 | 2. 0 | 2. 3 | 2. 5 |
| 5 | 1. 6 | 2. 0 | 2. 3 | 2. 4 | 2. 8 | 3. 2 | 3. 4 |
| 10 | 1. 9 | 2. 4 | 2. 8 | 2. 9 | 3. 3 | 3. 7 | 4. 2 |
| 25 | 2. 2 | 2. 8 | 3. 2 | 3. 4 | 3. 8 | 4. 5 | 4. 8 |
| 50 | 2. 6 | 3. 2 | 3. 6 | 3. 9 | 4. 4 | 4. 9 | 5. 7 |
| 100 | 2. 9 | 3. 6 | 4. 0 | 4. 4 | 4. 9 | 5. 7 | 6. 0 |

[1] Expresses the frequency of the specified number of inches of rainfall at given time intervals. For example, 2.3 inches of rain can be expected to fall in 2 hours once in every 5 years, and 1.9 inches can be expected in 30 minutes once in 10 years.

Since recording began at Cimarron in 1906, the annual precipitation has ranged from 8.58 inches in 1956 to 39.98 in 1951 (fig. 14).

Droughts severely affect yields in some years, and occasionally several successive years are drier than normal. Droughts were especially damaging during the period from 1931 to 1940 and also from 1952 to 1957. Because nearly all the cultivated soils in the county are subject to erosion by wind (*6*), periods of drought, together with the normally strong surface winds in spring, result in soil blowing in some fields.

Warm-season droughts are usually accompanied by abnormally high temperatures, which worsen the effects of dry weather. The change from the cold season to the warm season is often rapid, as reflected in the differences in the normal temperatures from March to April and from October to November. March has a normal average temperature of about 43° F., but that in April is about 54°. The change is even more noticeable between the normal temperature in October, which is 57°, and that of November, which is 43°.

Extremes in temperature at Cimarron have ranged from 22° below zero to 111°. Maximum daily temperatures, however, are usually in the 90's in the hottest month and in the 40's during the coldest. The average daily maximum and average daily minimum temperatures for each month and for the year are shown in table 9. This table also shows extreme temperatures that are likely to occur with a definite probability on at least 4 days, 2 years in 10.

During the cold season, daytime temperatures below 32° are unusual, but in most winters at least one period has temperatures below zero. The average annual minimum temperature at Cimarron since recording began was 10 below zero.

The length of the freeze-free period in Gray County averages about 170 days in the northwestern corner and about 180 days in the southeast (*3*). At Cimarron, the latest date on which a freezing temperature has been recorded is May 27; the earliest date in fall is September 27. The principal crops grown in the county are seldom damaged by freezes. Table 11 gives the probabilities that the last damaging temperatures in spring and the first in fall will occur on the dates indicated.

Surface winds are generally moderate in all seasons, but occasionally strong winds blow. The windiest months are March and April, when the average windspeed probably exceeds 15 miles per hour. The prevailing wind is southerly, but northerly and northwesterly winds are frequent, particularly in the cold season. Tornadoes, the most violent storms, occur occasionally but usually affect only small areas.

Clear to partly cloudy skies and abundant sunshine are dominant in Gray County. The percentage of possible days of sunshine averages about 70 for the year, but this percentage is nearly 80 during July and August.

TABLE 11.—*Probabilities of last damaging temperatures in spring and first in fall*

| Probability | Dates for given probability and temperature | | | | |
|---|---|---|---|---|---|
| | 16° F. or lower | 20° F. or lower | 24° F. or lower | 28° F. or lower | 32° F. or lower |
| Spring: | | | | | |
| 1 year in 10 later than | April 4 | April 10 | April 15 | April 27 | May 11 |
| 2 years in 10 later than | March 29 | April 4 | April 10 | April 22 | May 6 |
| 5 years in 10 later than | March 17 | March 25 | April 1 | April 12 | April 26 |
| Fall: | | | | | |
| 1 year in 10 earlier than | December 10 | November 29 | November 18 | November 12 | November 1 |
| 2 years in 10 earlier than | December 4 | November 24 | November 14 | November 7 | October 28 |
| 5 years in 10 earlier than | November 22 | November 13 | November 4 | October 29 | October 18 |

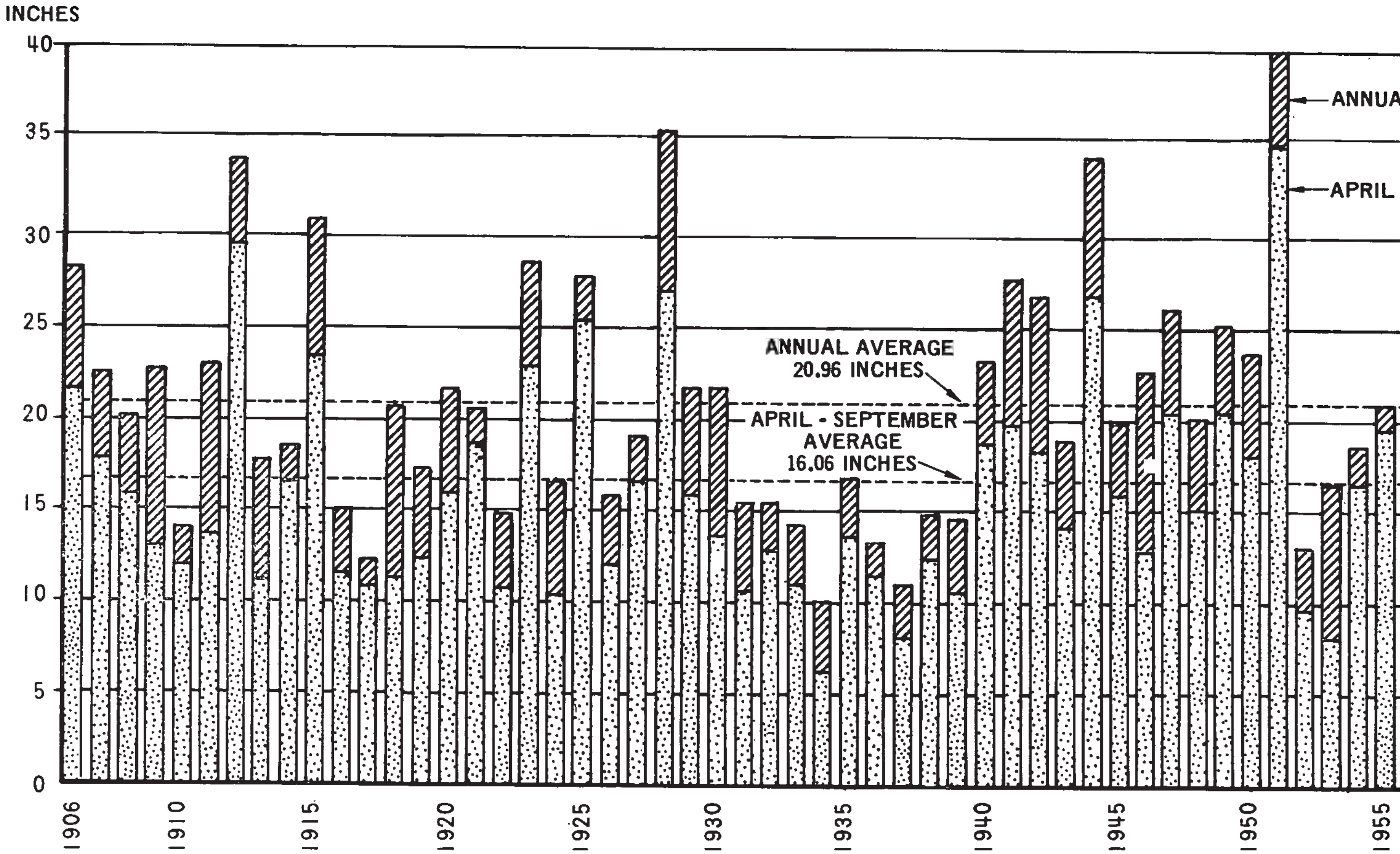


*Figure 14.*—Annual and April to September precipitation at Cimarron, Kansas, for the period 1906 to 1964.

## Agriculture

The agriculture of Gray County is based mainly on the growing of wheat and grain sorghum, and the grain from these crops is sold and shipped out of the county. Wheat is the main cash crop.

Farming operations are on a large scale and highly mechanized. Dryland farming predominates, but about 23,000 acres is irrigated. Sorghum and wheat are the main irrigated crops.

The number of livestock raised in the county has increased in the last 10 years. The ranches are located mainly in the sloping part of the county north of the Arkansas River, on the Arkansas River flood plain, and in the sandhills south of the river.

### *Crops*

Wheat and grain sorghum grow well under dryland farming in Gray County. On the silty and loamy soils, these crops are usually grown in a sequence of crop and fallow. During the fallow period, weeds are controlled so that moisture is conserved for use by the crop. On the sandy soils, sorghum is generally grown continuously because soil blowing is difficult to control during periods of fallow. A small acreage of alfalfa is grown under irrigation.

All tilling and harvesting are done with power equipment. Wheeled tractors are used for many purposes, and the wheat and grain sorghum are harvested by large, self-propelled combines. Most farmers own their tilling and planting equipment, but many pay to have part or all of their grain combined. Custom operators of combines from outside the county commonly furnish much of the labor and equipment needed.

The demand for farm labor is seasonal. Locally the supply is about adequate for planting and tilling, but transient laborers are generally needed when grain is harvested.

### *Pasture*

In 1962, pasture and rangeland amounted to about 107,000 acres. Most areas in pasture or range are not suited to farming, or they are adjacent to or surrounded by areas not suited and therefore cannot be cultivated conveniently. The sandhills south of the Arkansas River make up a large area that is used exclusively for grazing. This area supports native tall and mid grasses mixed with sand sagebrush. The remaining uplands in the county that are used for range support native short and mid grasses. Bottom lands along the Arkansas River that have a high water table support an abundant growth of the salt-tolerant native tall and mid grasses.

### *Livestock*

Beef cattle, the principal kind of livestock in the county, have increased in number in the past 10 years. In addition to the cattle raised, many animals are brought into the county during periods when sorghum stubble and wheat are available for grazing. Dairy farming has never been extensive in Gray County, and the number of milk cows has decreased in the county during the last several years.

### *Size, type, and tenure of farms*

The 1959 Census of Agriculture lists 617 farms in Gray County, as compared to 828 farms in 1930. The average size of farms increased from 591 acres in 1930 to about 894 acres in 1959.

The 1959 census also shows that 440 farmers resided on the farms they operated. The rest of the farmers lived in towns and in other counties.

Comparatively few farmers own all the land they operate. It is common for one farmer to rent land from two or more owners. The land is leased on a crop-share basis in which the landowners receive one-fourth or one-third of the crop, and the tenant receives the rest.

## Water Supply

In Gray County water for home use is obtained from drilled wells. Most of the water for livestock comes mainly from wells, but a few small dams have been constructed across intermittent streams in the uplands to impound water. Because the water in these ponds is not replenished during extended periods of drought, water for livestock must then be supplied from some other source.

Enough water to irrigate field crops is pumped from shallow wells that are drilled into alluvium along the Arkansas River and, in the uplands, from deep wells that are drilled into the Ogallala formation and into the undifferentiated Pleistocene deposits above the Dakota formation. Water is also diverted from the Arkansas River for irrigating crops and pastures.

## Transportation and Markets

Gray County has improved roads throughout the county except in some parts of the sandhills. U.S. Highway No. 50 extends from east to west and Kansas State Highway No. 23 extends from north to south through Cimarron, the county seat. U.S. Highway No. 56 extends from east to west through the southern one-third of the county and passes through Ensign, Montezuma, and Copeland.

The main line of Atchison, Topeka and Santa Fe Railway serves Cimarron, Ingalls, and Charleston, and a branch line extends through Ensign, Montezuma, and Copeland.

Facilities to handle and store grain are at Cimarron, Ingalls, Charleston, Ensign, Montezuma, and Copeland. The railroad provides adequate transportation to terminal elevators and markets to the east.

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## Glossary

**Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

**Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

**Caliche.** A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

**Clay film.** A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

**Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

**Complex, soil.** A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
*Loose.*—Noncoherent; soil does not hold together in a mass.
*Friable.*—When moist, soil crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
*Firm.*—When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
*Plastic.*—When wet, soil readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
*Sticky.*—When wet, soil adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.
*Hard.*—When dry, soil moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
*Soft.*—When dry, soil breaks into powder or individual grains under very slight pressure.
*Cemented.*—Hard and brittle; little affected by moistening.

**Permeability.** The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

**Phase, soil.** A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects management.

**Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Saline soil.** A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

**Sand.** Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

**Series, soil.** A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

**Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

**Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), prismatic (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the profile below plow depth.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand,

loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Tilth, soil.** The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

**Type, soil.** A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

**Water-holding capacity.** The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

# Accessibility Statement

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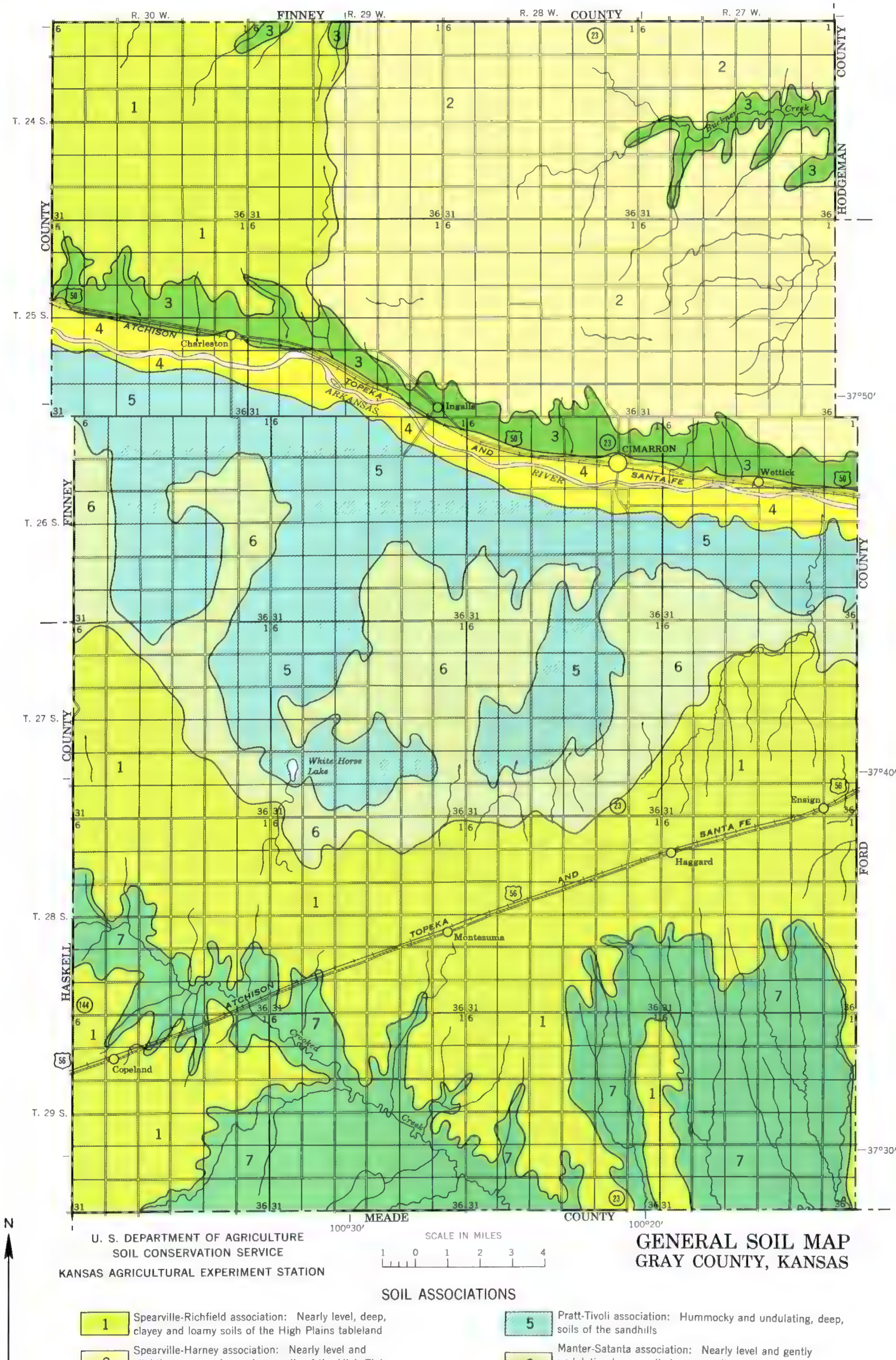
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

### Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

### All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).




U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

SCALE IN MILES

1 0 1 2 3 4

# GENERAL SOIL MAP
## GRAY COUNTY, KANSAS

### SOIL ASSOCIATIONS

1 Spearville-Richfield association: Nearly level, deep, clayey and loamy soils of the High Plains tableland

2 Spearville-Harney association: Nearly level and slightly concave, deep, clayey soils of the High Plains tableland

3 Mansic-Ulysses association: Sloping to steep, deep, loamy soils of the High Plains

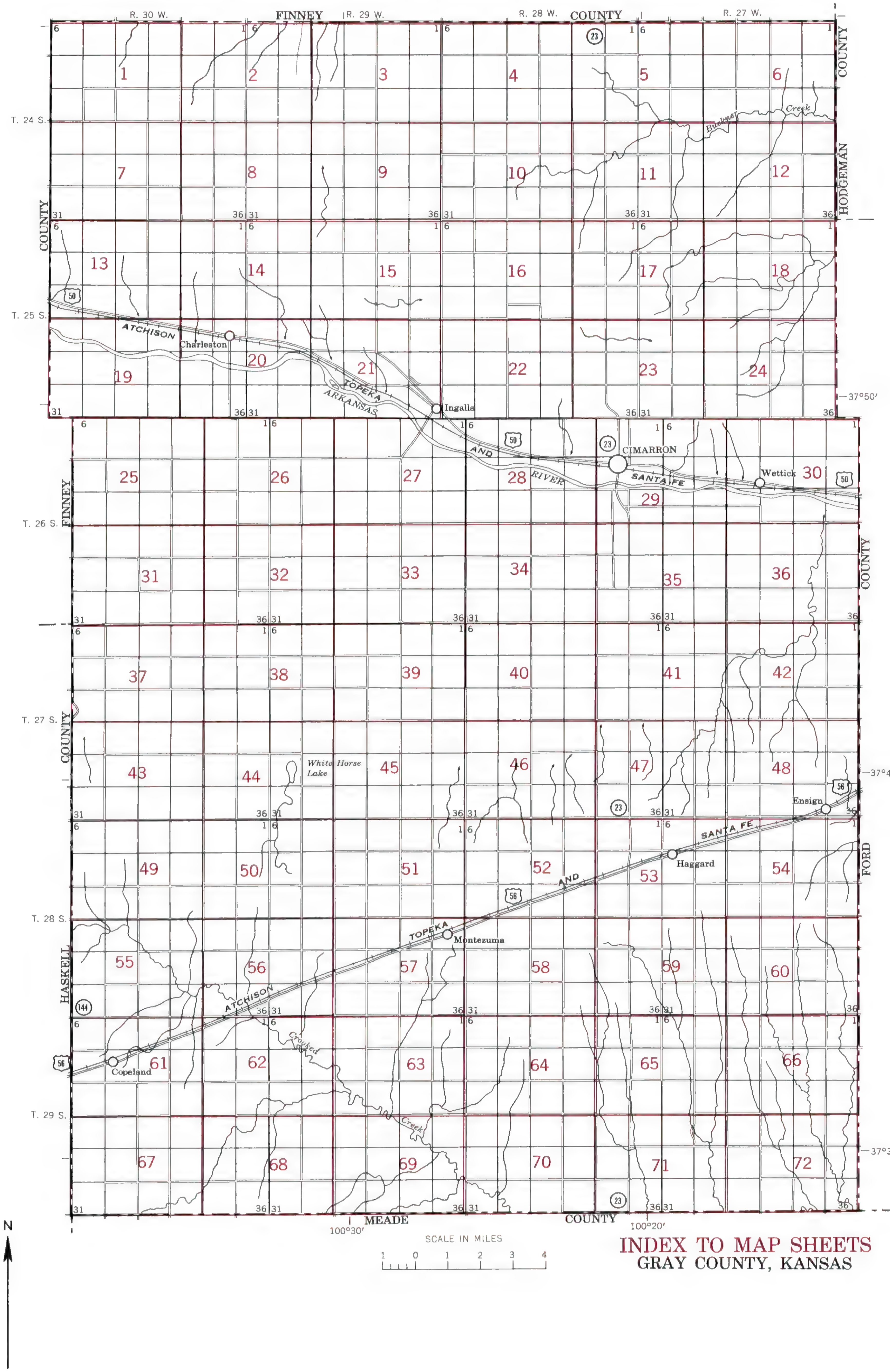
4 Las Animas-Leshara-Lesho association: Nearly level, deep and shallow, well-drained and somewhat poorly drained loamy soils in the valley of the Arkansas River

5 Pratt-Tivoli association: Hummocky and undulating, deep, soils of the sandhills

6 Manter-Santanta association: Nearly level and gently undulating loamy soils in areas adjacent to the sandhills

7 Richfield-Ulysses-Mansic association: Nearly level to sloping, deep, loamy soils of the Crooked Creek drainage area

August 1966




# INDEX TO MAP SHEETS
## GRAY COUNTY, KANSAS

## SOIL LEGEND

| SYMBOL | NAME |
|---|---|
| An | Alluvial land |
| Bc | Bridgeport silty clay loam, 0 to 1 percent slopes |
| Bd | Bridgeport silty clay loam, 1 to 3 percent slopes |
| Bo | Blown-out land |
| Da | Dale silt loam |
| Gr | Gravelly broken land |
| Ha | Harney silt loam, 0 to 1 percent slopes |
| La | Las Animas-Lesho complex, alkali |
| Lc | Las Animas soils |
| Ld | Las Animas sandy loam |
| Le | Leshara clay loam |
| Lh | Lesho clay loam |
| Lk | Lesho-Sweetwater complex |
| Ll | Lincoln soils |
| Lo | Lofton silty clay loam |
| Lu | Lubbock loam |
| Md | Mansic clay loam, 3 to 6 percent slopes |
| Me | Mansic clay loam, 6 to 15 percent slopes |
| Mf | Mansic complex, 3 to 6 percent slopes, eroded |
| Mh | Mansic complex, 6 to 15 percent slopes, eroded |
| Mm | Manter fine sandy loam, 0 to 1 percent slopes |
| Mn | Manter fine sandy loam, 1 to 3 percent slopes |
| Mo | Manter fine sandy loam, undulating, eroded |
| Mp | Mansker-Potter complex |
| Mu | Manter-Ulysses complex, undulating |
| Pa | Pratt loamy fine sand, undulating |
| Pg | Pratt loamy fine sand, gravel substratum |
| Pt | Pratt-Tivoli loamy fine sands |
| Ra | Randall clay |
| Rm | Richfield silt loam, 0 to 1 percent slopes |
| Rn | Richfield silt loam, 1 to 3 percent slopes |
| Ro | Richfield silty clay loam, 1 to 3 percent slopes, eroded |
| Rs | Richfield-Spearville complex, 0 to 1 percent slopes |
| Sa | Satanta loam, 0 to 1 percent slopes |
| Sb | Satanta loam, 1 to 3 percent slopes |
| Sp | Spearville silty clay loam, 0 to 1 percent slopes |
| Sr | Spearville complex, 1 to 3 percent slopes, eroded |
| Sw | Sweetwater soils |
| Tf | Tivoli fine sand |
| Ua | Ulysses silt loam, 0 to 1 percent slopes |
| Ub | Ulysses silt loam, 1 to 3 percent slopes |
| Uc | Ulysses silt loam, 3 to 6 percent slopes |
| Um | Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded |

## CONVENTIONAL SIGNS

### WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries

Mine dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil or gas well

### BOUNDARIES

National or state

County

Township, U. S.

Section line, corner

Reservation

Land grant

### DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches

CANAL

DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells

flowing

Springs

Marsh

Wet spot

Alluvial fan

Drainage end

### RELIEF

Escarpments
- Bedrock
- Other

Prominent peak

Depression, unclassified

### SOIL SURVEY DATA

Soil boundary

and symbol

Dx

Gravel

Stones

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

Blowout, wind erosion

Gullies

Soil map constructed 1966 by Cartographic Division, Soil Conservation Service, USDA, from 1960 aerial photographs. Controlled mosaic based on Kansas plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.

## GUIDE TO MAPPING UNITS

[For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs.

See table 1, page 7, for approximate acreage and proportionate extent of the soils; see table 2, page 27, for predicted yields of dryland crops; and see table 3, page 30, for predicted yields of irrigated crops. For descriptions of the range sites, see pages 31, 32, and 33. For information on windbreak suitability groups, see section beginning on page 34, and for information significant to engineering, see section beginning on page 36. Dashed lines indicate soil is not irrigated or is not placed in a windbreak suitability group or range site]

| Map symbol | Mapping unit | Page | Dryland capability unit | | Irrigated capability unit | | Windbreak suitability group | Range site |
|---|---|---|---|---|---|---|---|---|
| | | | Symbol | Page | Symbol | Page | Name | Name |
| An | Alluvial land | 6 | VIw-1 | 26 | ----- | -- | Loamy Lowland | Loamy Lowland |
| Bc | Bridgeport silty clay loam, 0 to 1 percent slopes | 7 | IIc-1 | 24 | I-1 | 28 | Loamy Lowland | Loamy Terrace |
| Bd | Bridgeport silty clay loam, 1 to 3 percent slopes | 8 | IIIe-1 | 24 | IIe-1 | 28 | Loamy Lowland | Loamy Terrace |
| Bo | Blown-out land | 7 | VIIe-1 | 26 | ----- | -- | ------------- | Choppy Sands |
| Da | Dale silt loam | 8 | IIc-2 | 24 | I-1 | 28 | Loamy Lowland | Loamy Terrace |
| Gr | Gravelly broken land | 8 | VIIs-1 | 27 | ----- | -- | ------------- | Gravelly Hills |
| Ha | Harney silt loam, 0 to 1 percent slopes | 9 | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| La | Las Animas-Lesho complex, alkali | 10 | IVs-1 | 25 | ----- | -- | Subirrigated Loamy Lowland | Saline Subirrigated |
| Lc | Las Animas soils | 10 | VIs-1 | 26 | ----- | -- | Subirrigated Loamy Lowland | Saline Subirrigated |
| Ld | Las Animas sandy loam | 10 | IVw-2 | 25 | IIIw-2 | 30 | Subirrigated Loamy Lowland | Saline Subirrigated |
| Le | Leshara clay loam | 11 | IIIw-1 | 24 | IIw-1 | 28 | Subirrigated Loamy Lowland | Saline Subirrigated |
| Lh | Lesho clay loam | 11 | IVw-2 | 24 | IIIw-1 | 30 | Subirrigated Loamy Lowland | Saline Subirrigated |
| Lk | Lesho-Sweetwater complex | 11 | VIs-1 | 26 | ----- | -- | Subirrigated Loamy Lowland | Saline Subirrigated |
| Ll | Lincoln soils | 12 | VIIw-1 | 26 | ----- | -- | --------------- | -------------- |
| Lo | Lofton silty clay loam | 12 | IVw-1 | 25 | ----- | -- | Clayey Upland | Clay Upland |
| Lu | Lubbock loam | 13 | IIc-2 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| Md | Mansic clay loam, 3 to 6 percent slopes | 13 | IVe-2 | 25 | IIIe-4 | 29 | Loamy Upland | Limy Upland |
| Me | Mansic clay loam, 6 to 15 percent slopes | 13 | VIe-1 | 26 | ----- | -- | Loamy Upland | Limy Upland |
| Mf | Mansic complex, 3 to 6 percent slopes, eroded | 13 | IVe-2 | 25 | IIIe-4 | 29 | Loamy Upland | Limy Upland |
| Mh | Mansic complex, 6 to 15 percent slopes, eroded | 14 | VIe-1 | 26 | ----- | -- | Loamy Upland | Limy Upland |
| Mm | Manter fine sandy loam, 0 to 1 percent slopes | 15 | IIe-2 | 23 | IIs-1 | 28 | Sandy Upland | Sandy |
| Mn | Manter fine sandy loam, 1 to 3 percent slopes | 15 | IIIe-3 | 24 | IIIe-1 | 29 | Sandy Upland | Sandy |
| Mo | Manter fine sandy loam, undulating, eroded | 15 | IVe-3 | 25 | IIIe-1 | 29 | Sandy Upland | Sandy |
| Mp | Mansker-Potter complex | 14 | | | | | | |
| | Mansker soil | -- | VIe-3 | 26 | ----- | -- | ------------ | Limy Upland |
| | Potter soil | -- | VIe-3 | 26 | ----- | -- | ------------ | Breaks |
| Mu | Manter-Ulysses complex, undulating | 15 | | | | | | |
| | Manter soil | -- | IIIe-3 | 24 | IIIe-1 | 29 | Sandy Upland | Sandy |
| | Ulysses soil | -- | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| Pa | Pratt loamy fine sand, undulating | 16 | IVe-1 | 25 | IIIe-2 | 29 | Sandy Upland | Sands |
| Pg | Pratt loamy fine sand, gravel substratum | 16 | IVe-1 | 25 | IVs-1 | 30 | Sandy Upland | Sands |
| Pt | Pratt-Tivoli loamy fine sands | 16 | VIe-2 | 26 | ----- | -- | Sandy Upland | Sands |
| Ra | Randall clay | 17 | VIw-2 | 26 | ----- | -- | ------------ | ----- |
| Rm | Richfield silt loam, 0 to 1 percent slopes | 17 | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| Rn | Richfield silt loam, 1 to 3 percent slopes | 17 | IIe-1 | 23 | IIe-1 | 28 | Loamy Upland | Loamy Upland |
| Ro | Richfield silty clay loam, 1 to 3 percent slopes, eroded | 17 | IIIe-1 | 24 | IIe-1 | 28 | Loamy Upland | Loamy Upland |
| Rs | Richfield-Spearville complex, 0 to 1 percent slopes | 17 | | | | | | |
| | Richfield soil | -- | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| | Spearville soil | -- | IIs-1 | 24 | IIs-2 | 29 | Clayey Upland | Clay Upland |
| Sa | Satanta loam, 0 to 1 percent slopes | 18 | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| Sb | Satanta loam, 1 to 3 percent slopes | 18 | IIe-1 | 23 | IIe-1 | 28 | Loamy Upland | Loamy Upland |
| Sp | Spearville silty clay loam, 0 to 1 percent slopes | 19 | IIs-1 | 24 | IIs-2 | 29 | Clayey Upland | Clay Upland |
| Sr | Spearville complex, 1 to 3 percent slopes, eroded | 19 | IIIe-2 | 24 | IIIe-3 | 29 | Clayey Upland | Clay Upland |
| Sw | Sweetwater soils | 20 | Vw-1 | 25 | ----- | -- | Subirrigated Loamy Lowland | Saline Subirrigated |
| Tf | Tivoli fine sand | 20 | VIIe-1 | 26 | ----- | -- | -------------- | Choppy Sand |
| Ua | Ulysses silt loam, 0 to 1 percent slopes | 21 | IIc-1 | 24 | I-1 | 28 | Loamy Upland | Loamy Upland |
| Ub | Ulysses silt loam, 1 to 3 percent slopes | 21 | IIIe-1 | 24 | IIe-1 | 28 | Loamy Upland | Loamy Upland |
| Uc | Ulysses silt loam, 3 to 6 percent slopes | 21 | IVe-2 | 25 | IIIe-4 | 29 | Loamy Upland | Loamy Upland |
| Um | Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded | 22 | | | | | | |
| | Ulysses soil | -- | IVe-2 | 25 | IIIe-4 | 29 | Loamy Upland | Loamy Upland |
| | Colby soil | -- | IVe-2 | 25 | IIIe-4 | 29 | Loamy Upland | Limy Upland |

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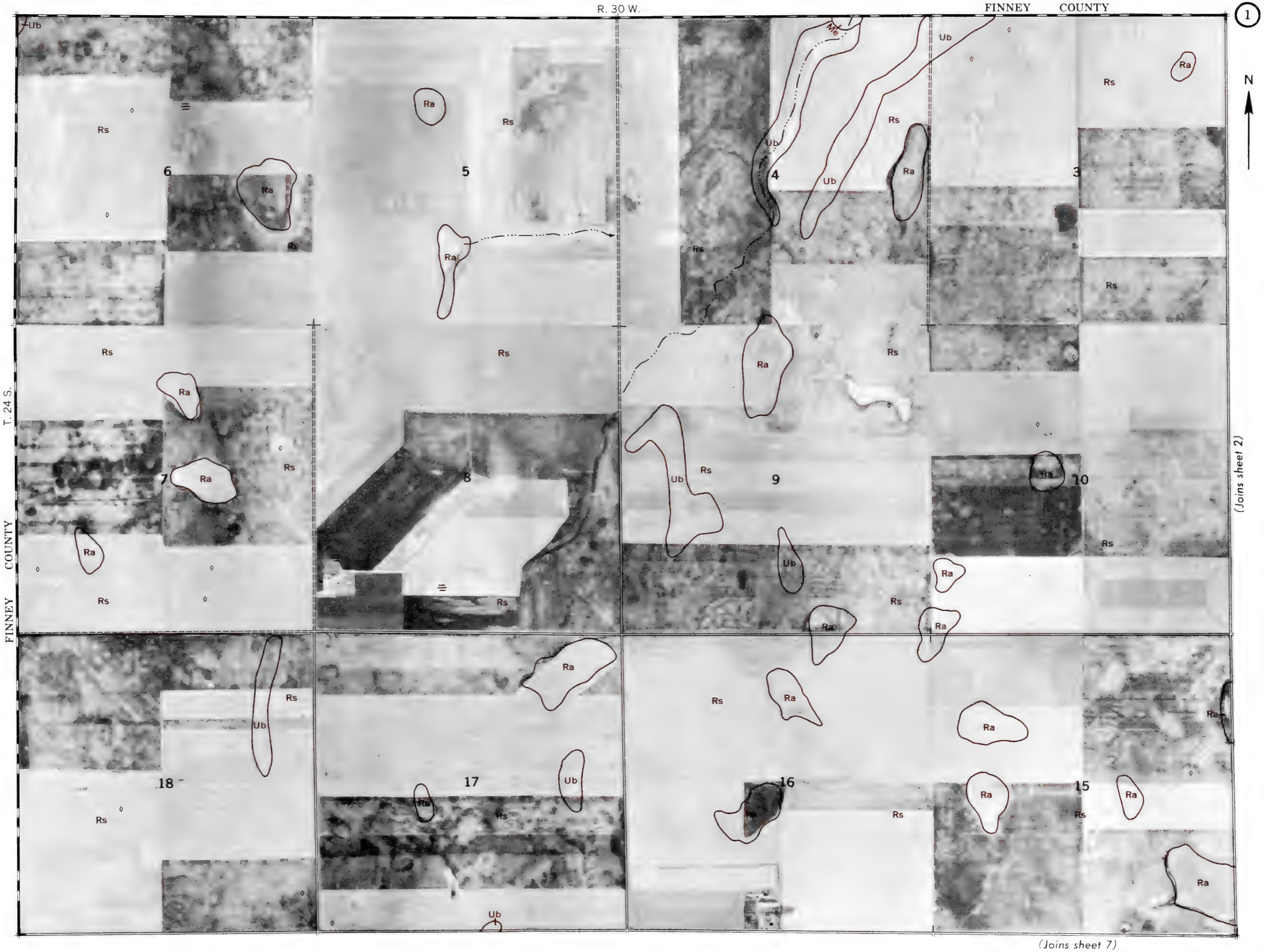
GRAY COUNTY, KANSAS — SHEET NUMBER 1

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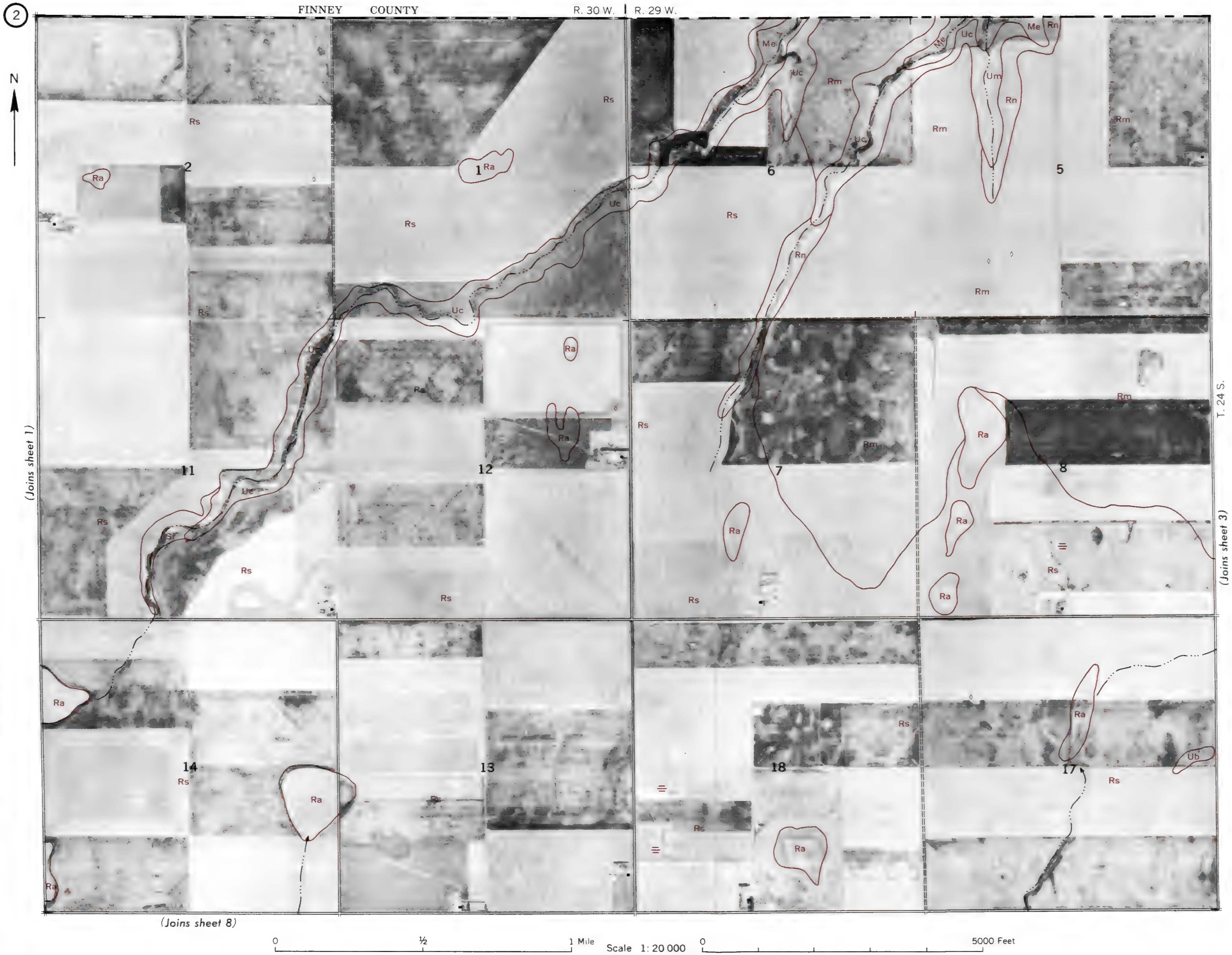
This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.



2
FINNEY COUNTY
R. 30 W.
R. 29 W.
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T. 24 S.
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(Joins sheet 3)
(Joins sheet 8)
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1 Mile
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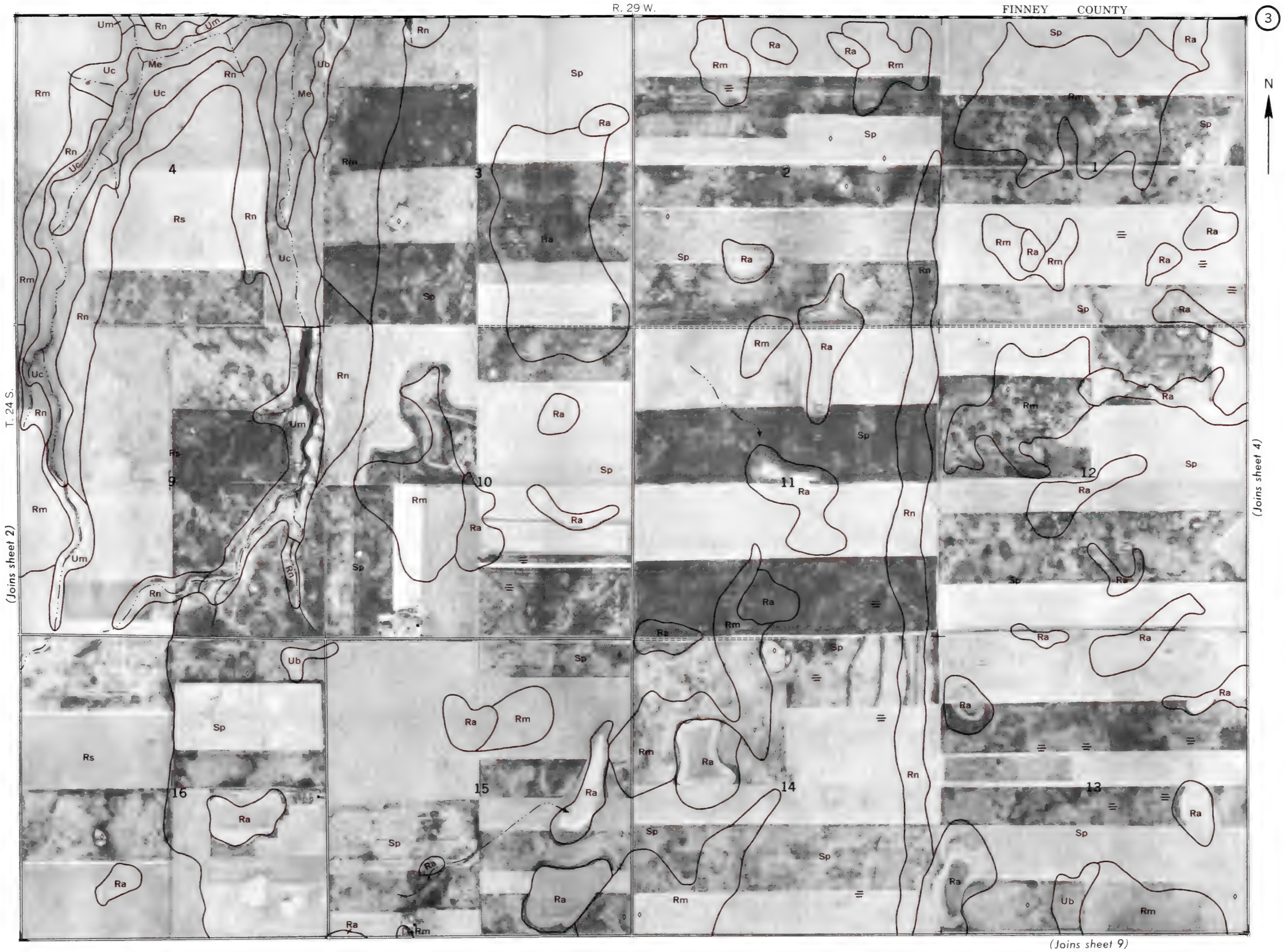


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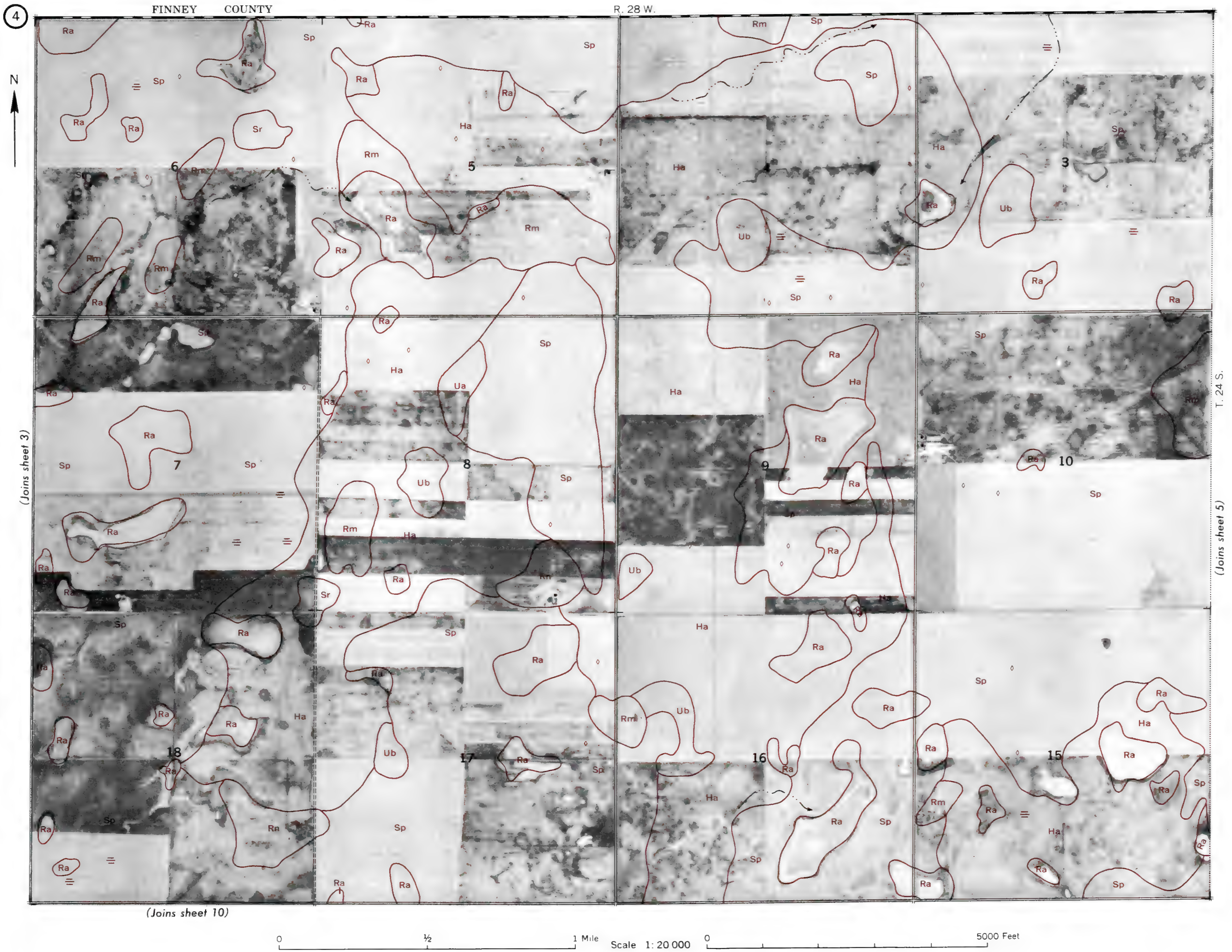
4
FINNEY COUNTY
R. 28 W.
N
T. 24 S.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 10)
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5
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9
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16
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1 Mile
Scale 1: 20 000
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5000 Feet


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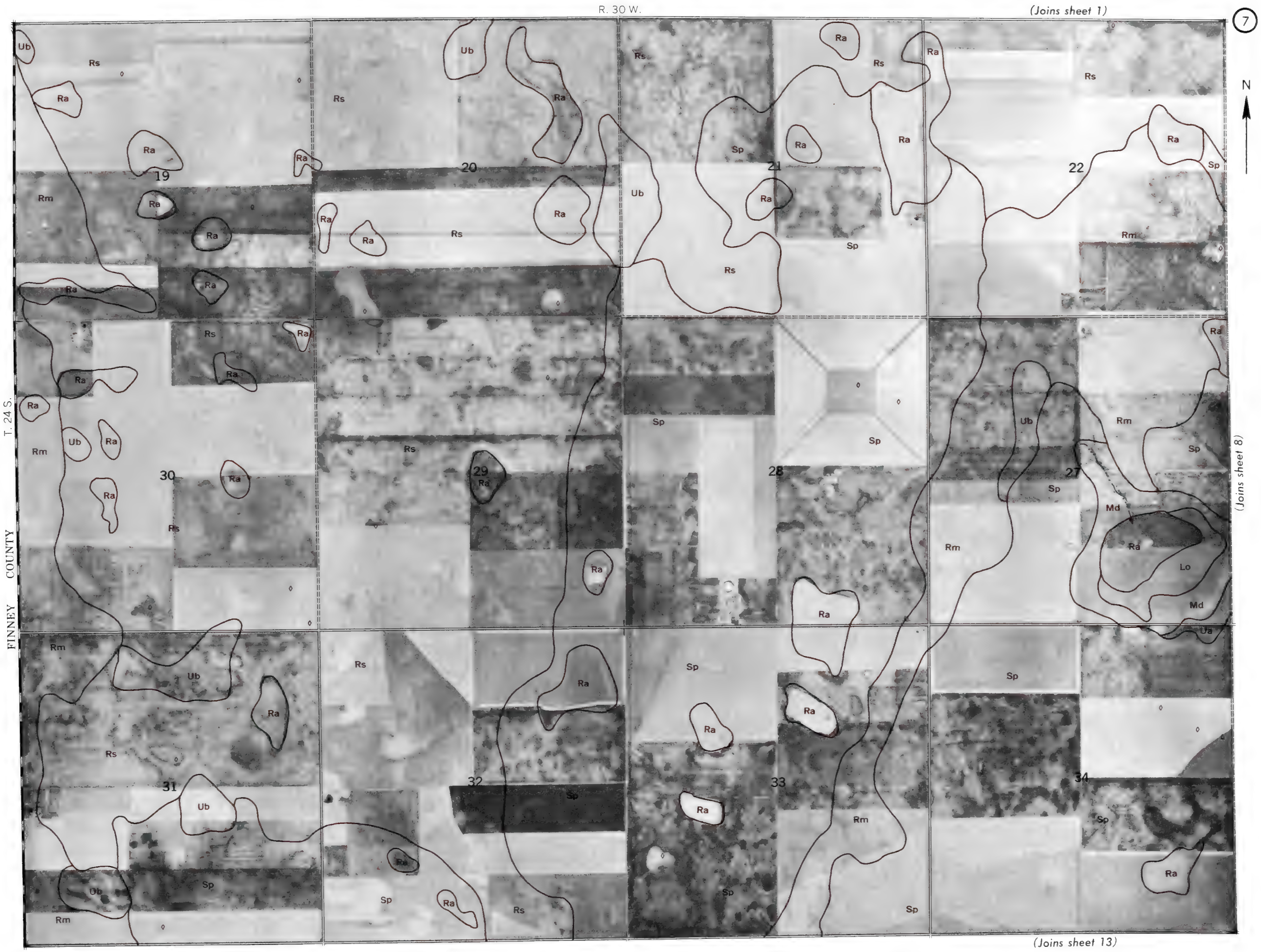


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Range, township, and section corners shown on this map are indefinite


8
(Joins sheet 2)
R. 30 W.
R. 29 W.
N
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 14)
T. 24 S.
23
24
19
20
26
25
30
29
35
36
31
32
Rs
Ra
Sp
Rm
Ua
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Md
0
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1 Mile
Scale 1: 20 000
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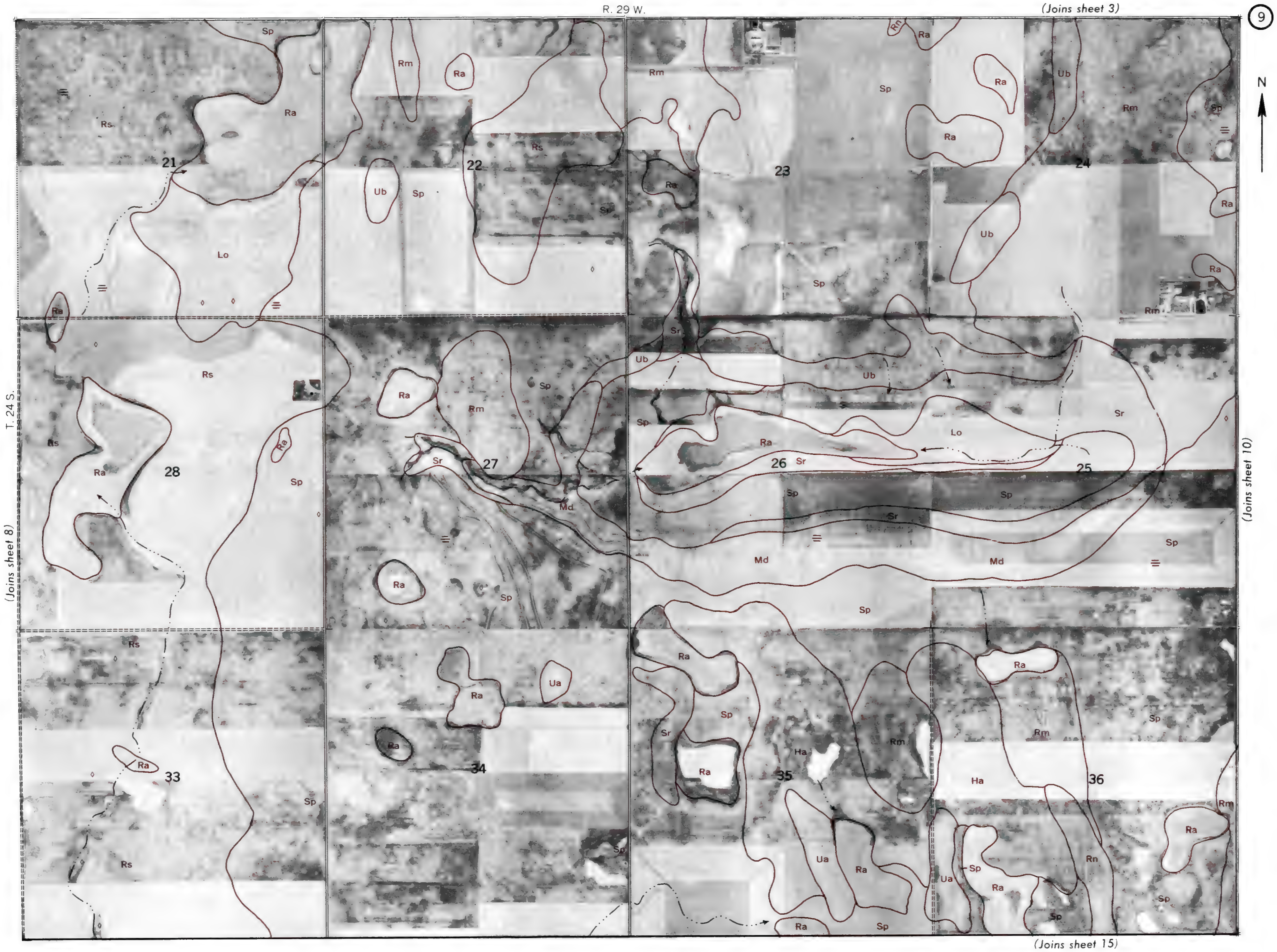


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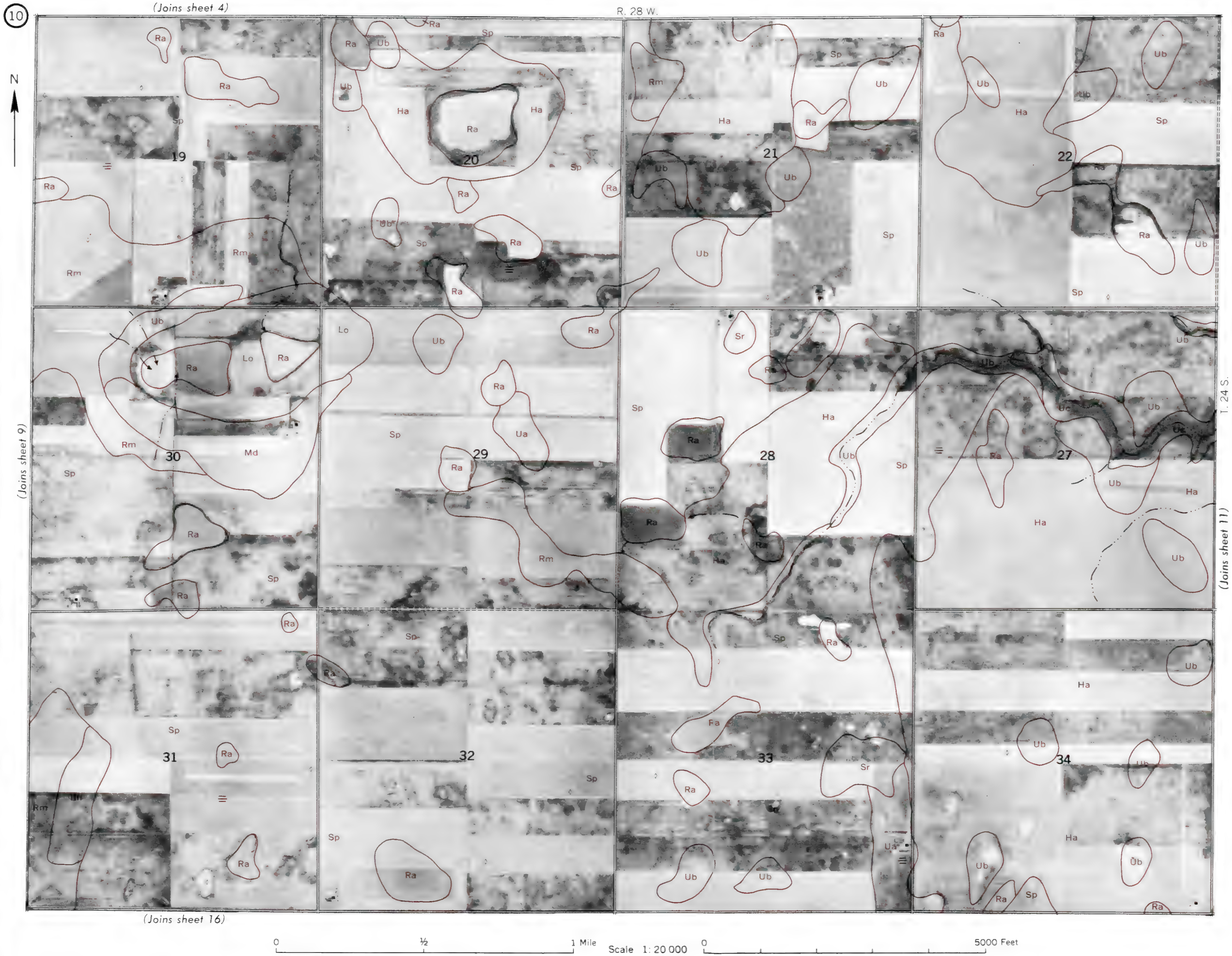
10
(Joins sheet 4)
R. 28 W.
N
(Joins sheet 9)
(Joins sheet 11)
T. 24 S.
(Joins sheet 16)
19
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1 Mile
Scale 1: 20 000
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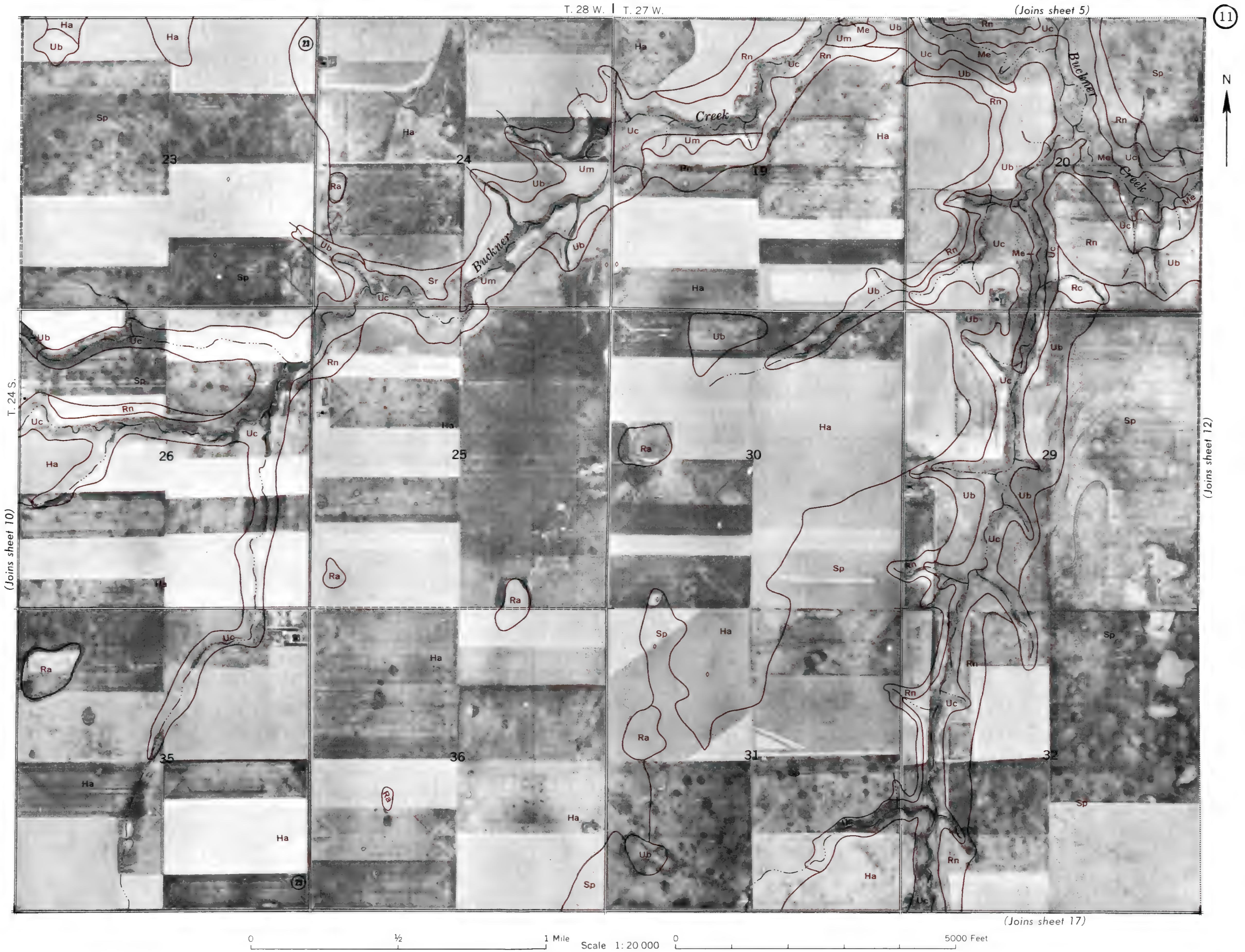
5000 Feet

GRAY COUNTY, KANSAS — SHEET NUMBER 11

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Range, township, and section corners shown on this map are indefinite.

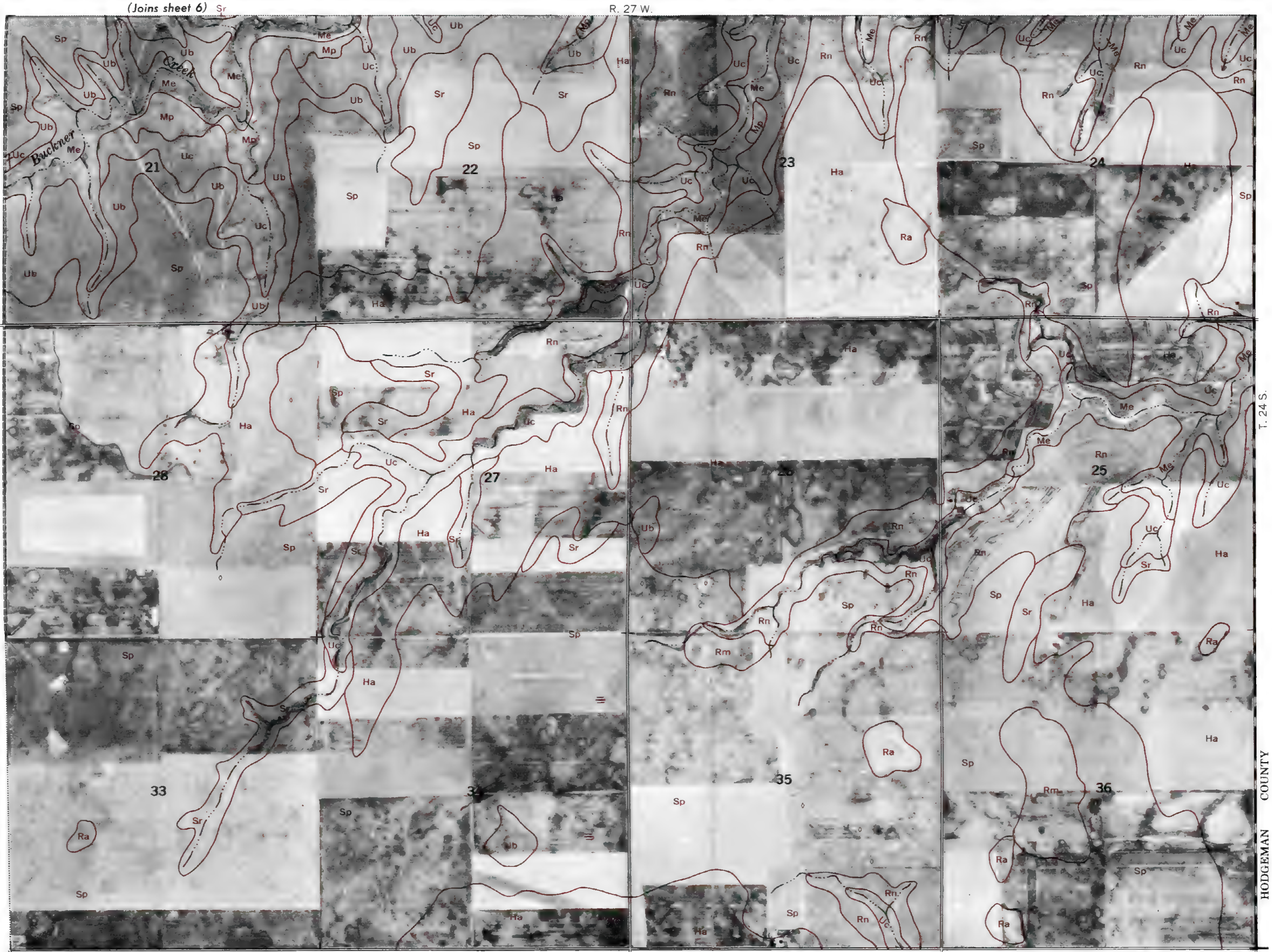
12

(Joins sheet 6)

R. 27 W.

N

(Joins sheet 11)




T. 24 S.

HODGEMAN COUNTY

(Joins sheet 18)

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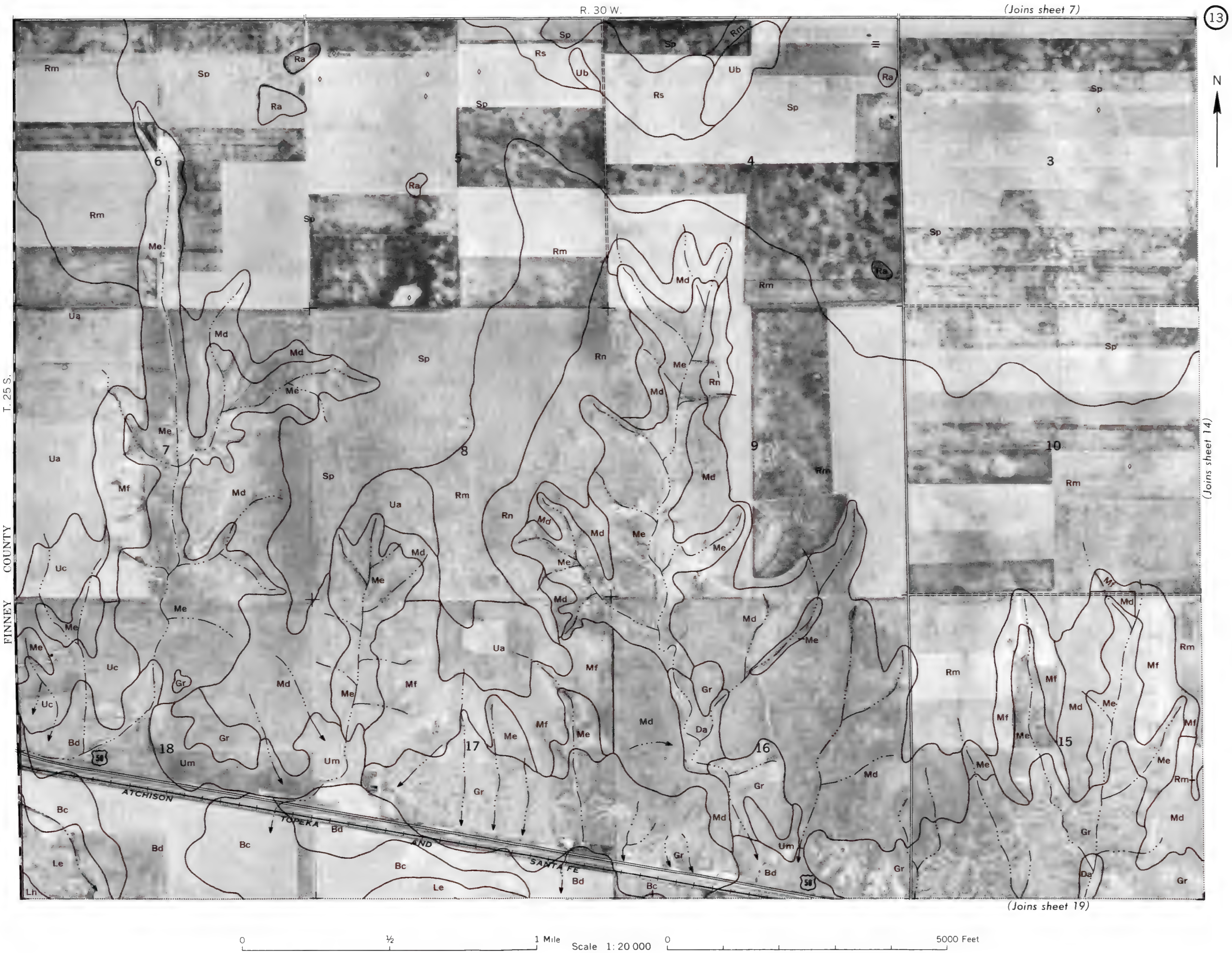

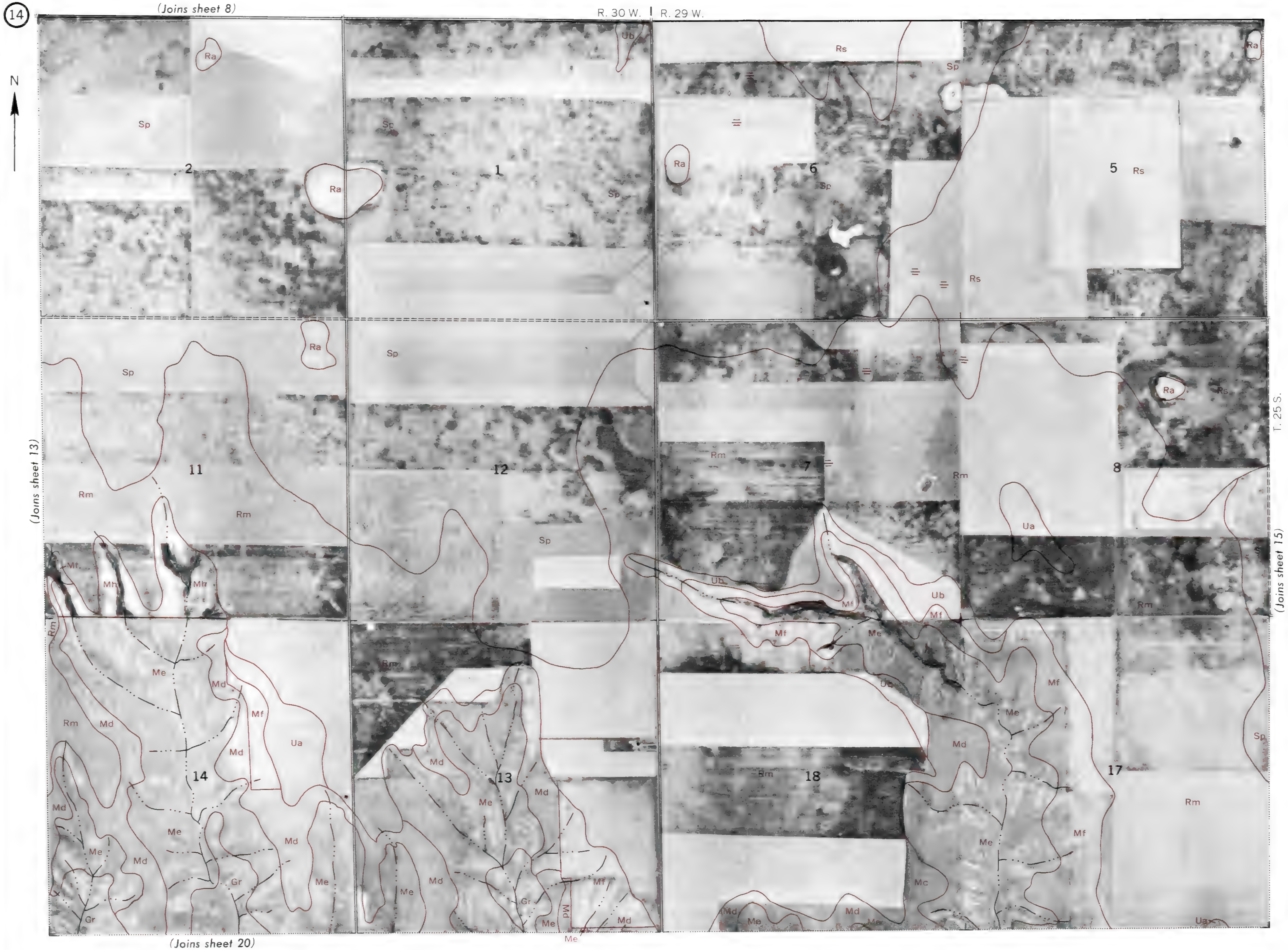


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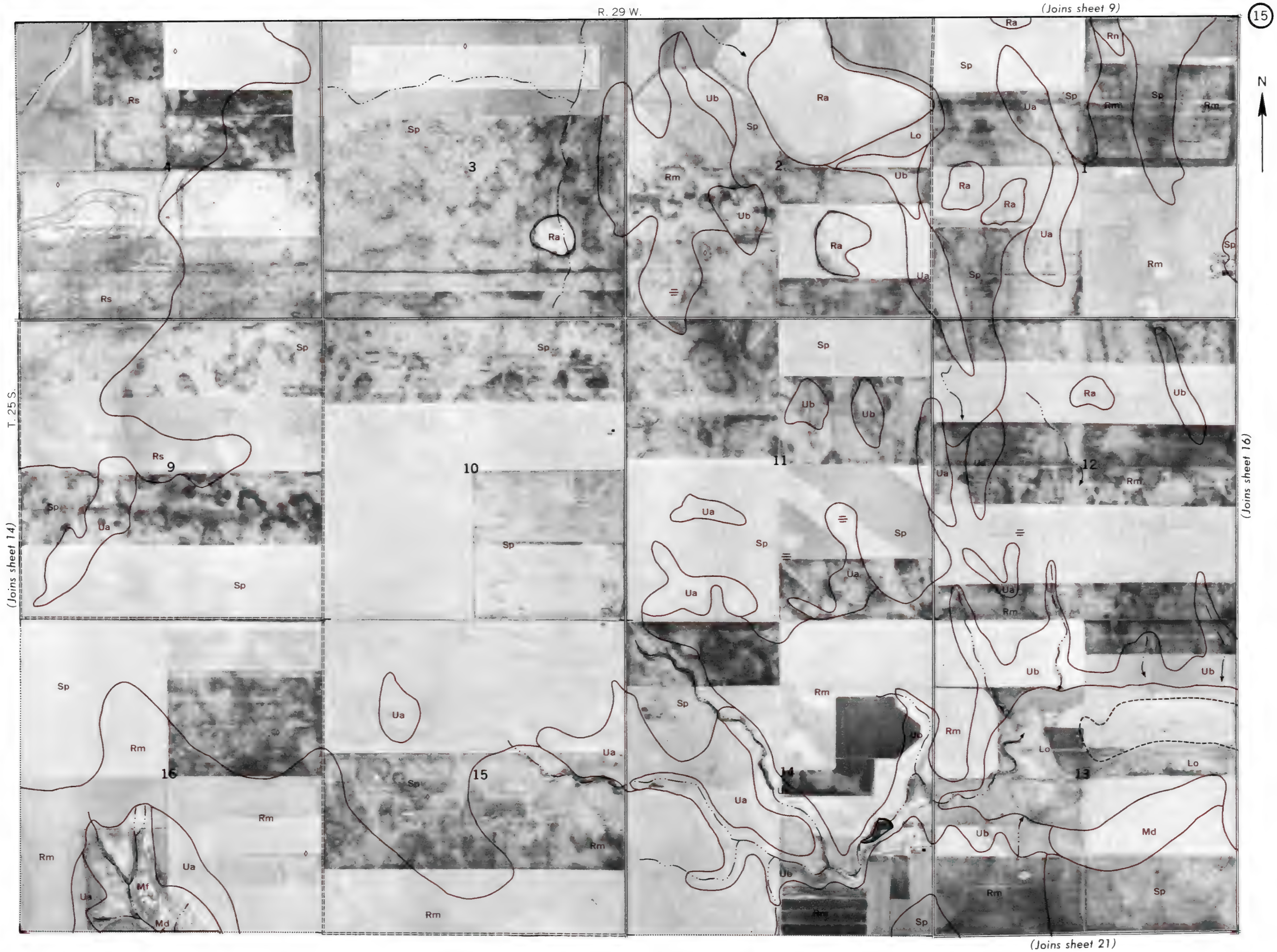


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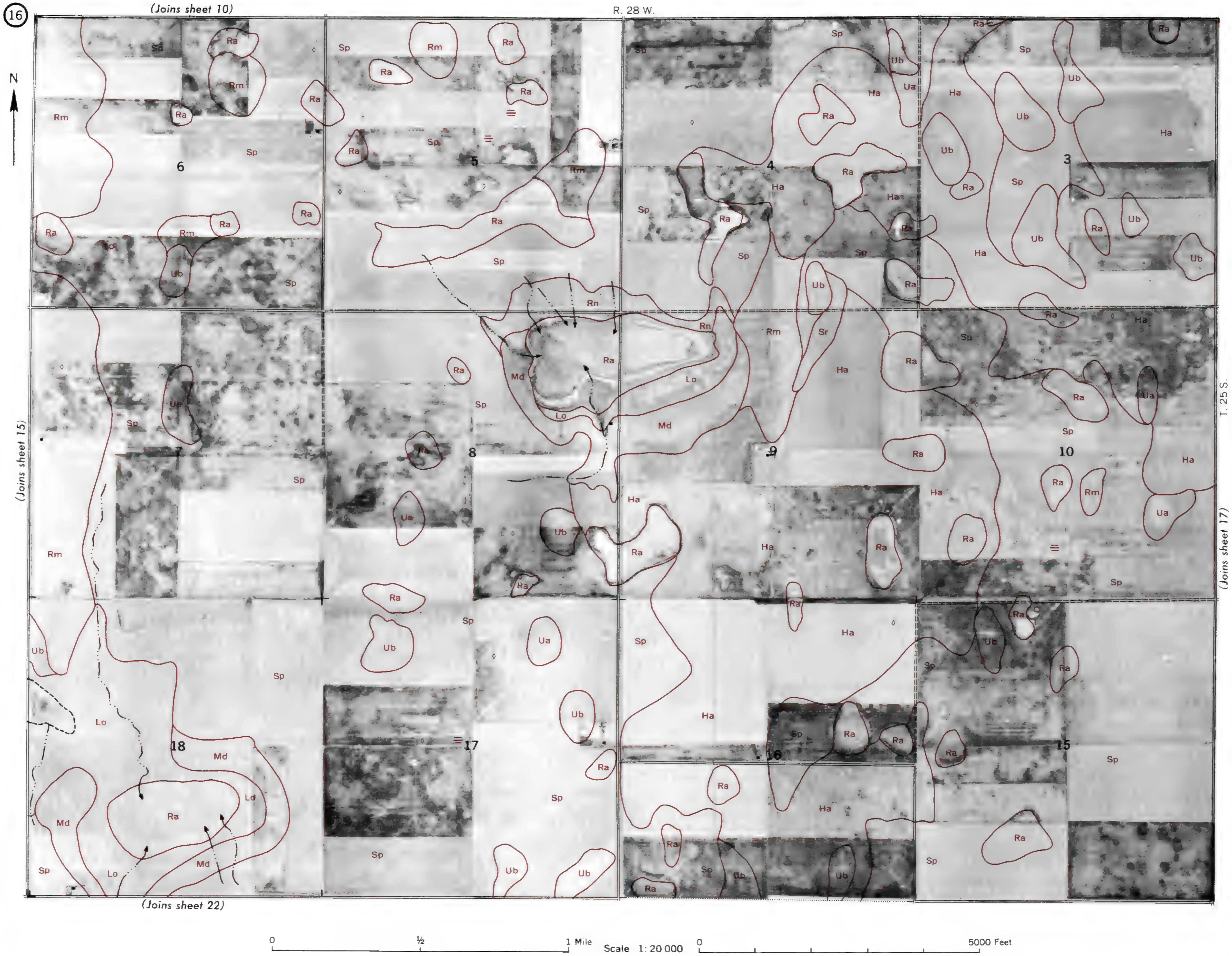
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY KANSAS — SHEET NUMBER 16



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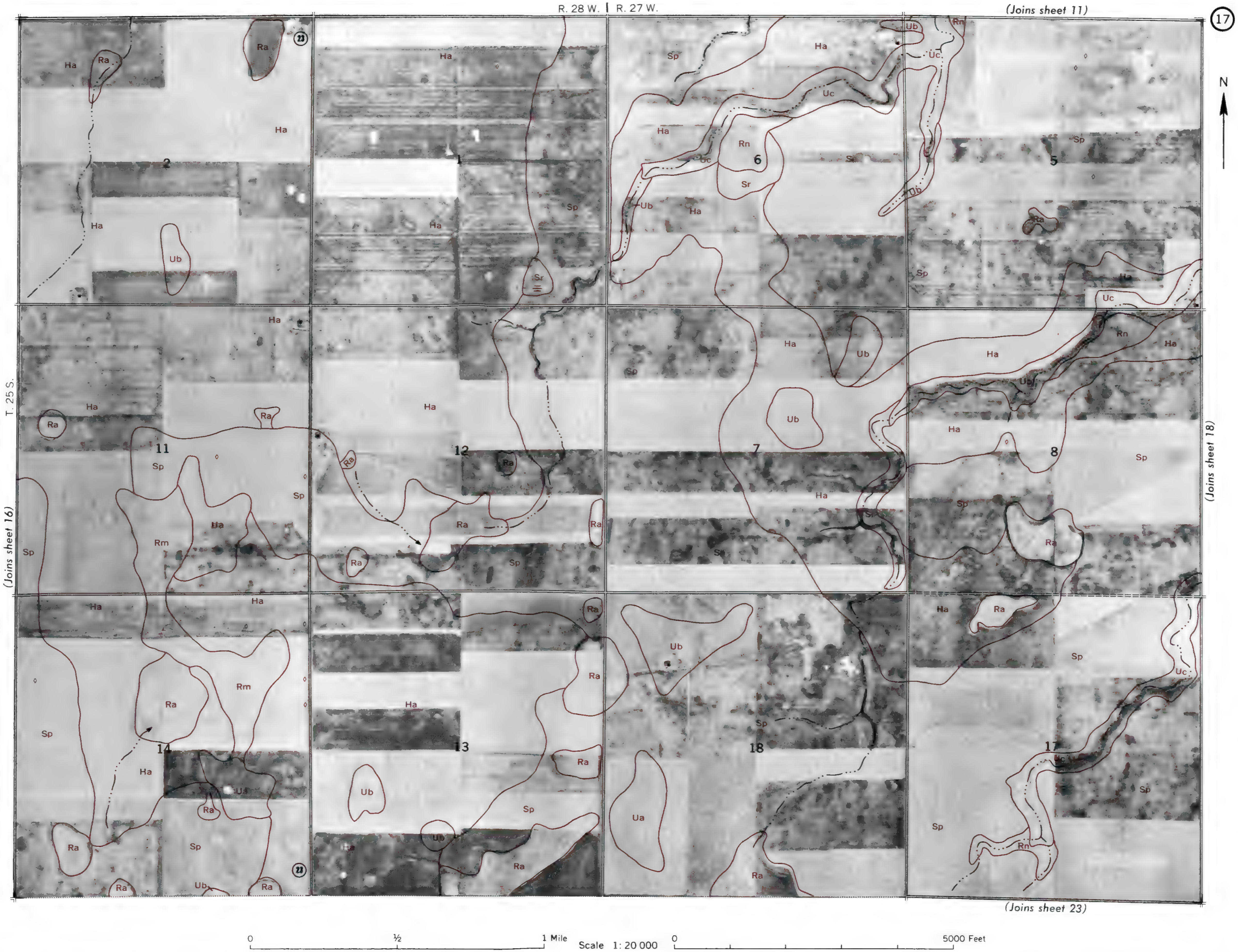
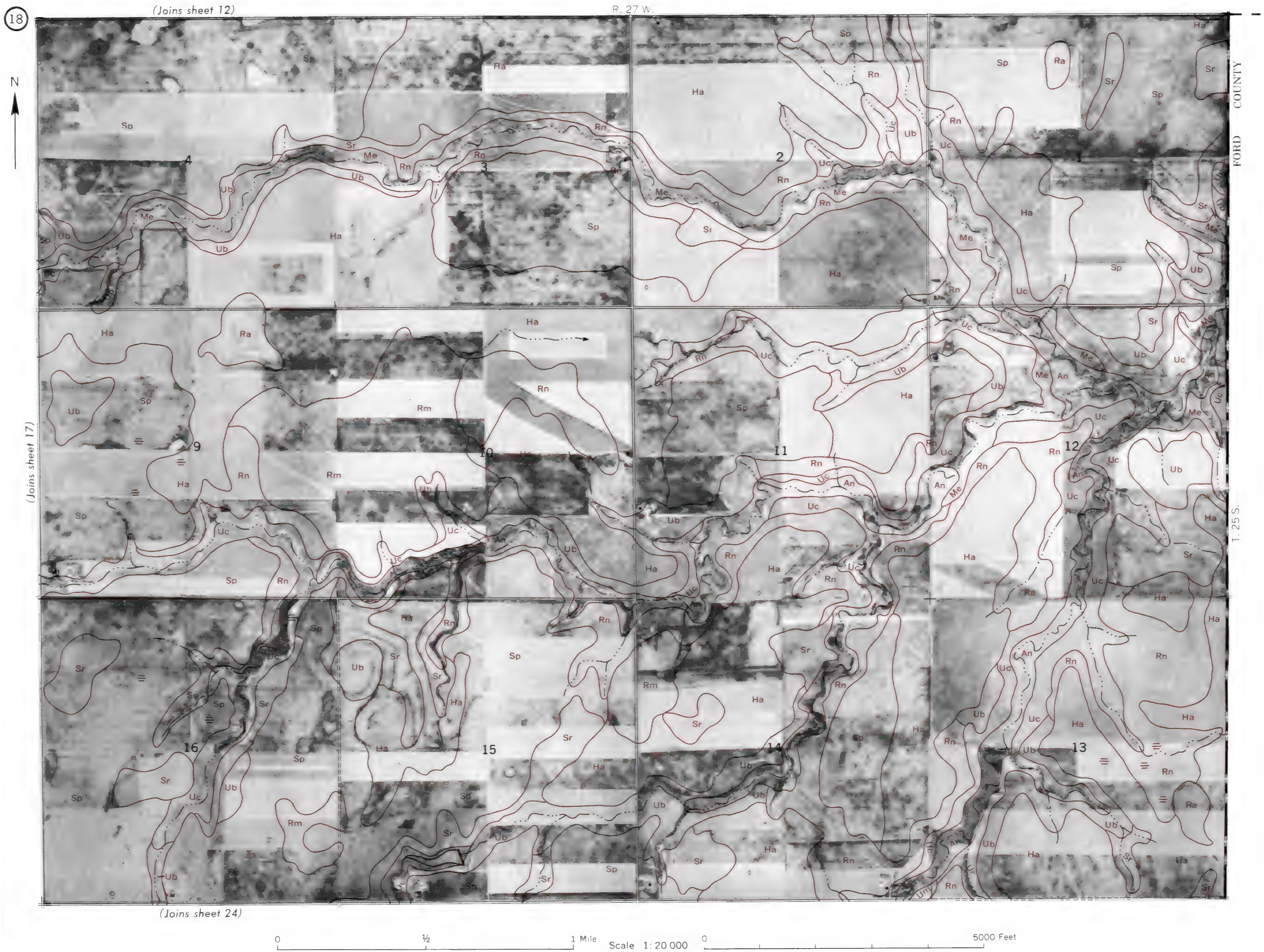



This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


18
(Joins sheet 12)
R. 27 W.
N
FORD COUNTY
(Joins sheet 17)
T. 25 S.
(Joins sheet 24)
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1 Mile
Scale 1: 20 000
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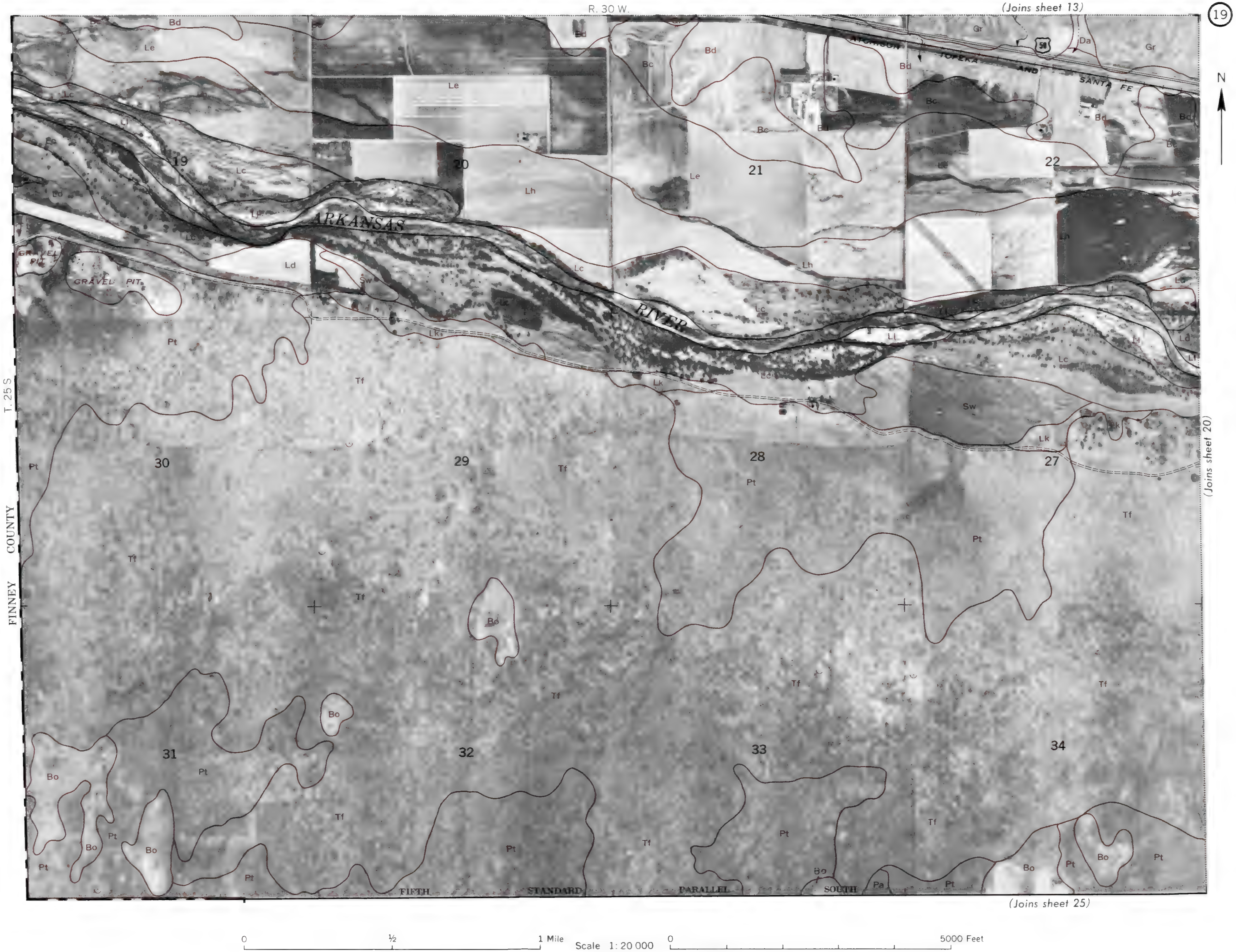
5000 Feet

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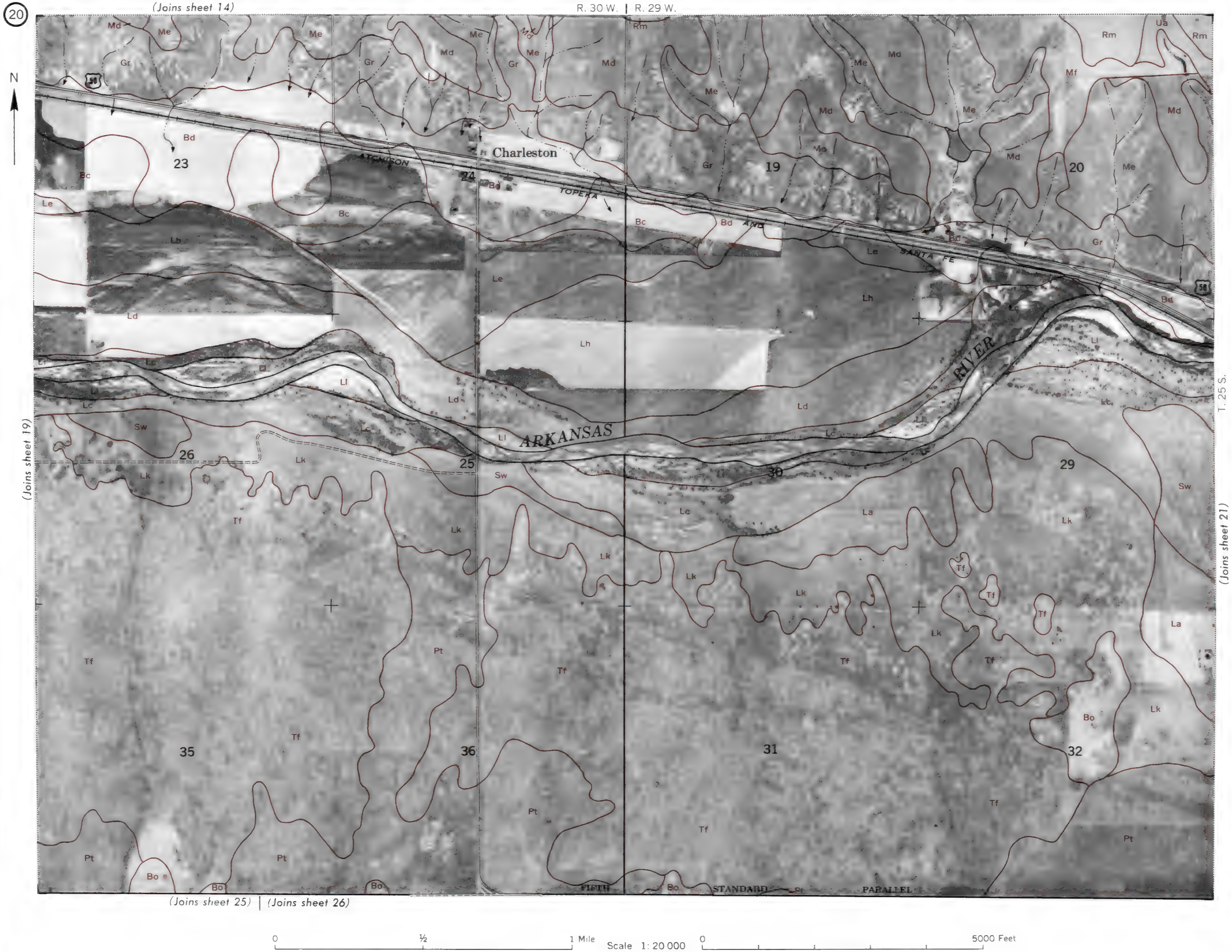
Range, township, and section corners shown on this map are indefinite.


20
(Joins sheet 14)
R. 30 W. | R. 29 W.
N
Charleston
ATCHISON TOPEKA AND SANTA FE
ARKANSAS RIVER
(Joins sheet 19)
(Joins sheet 21)
T. 25 S.
(Joins sheet 25) | (Joins sheet 26)
FIFTH STANDARD PARALLEL
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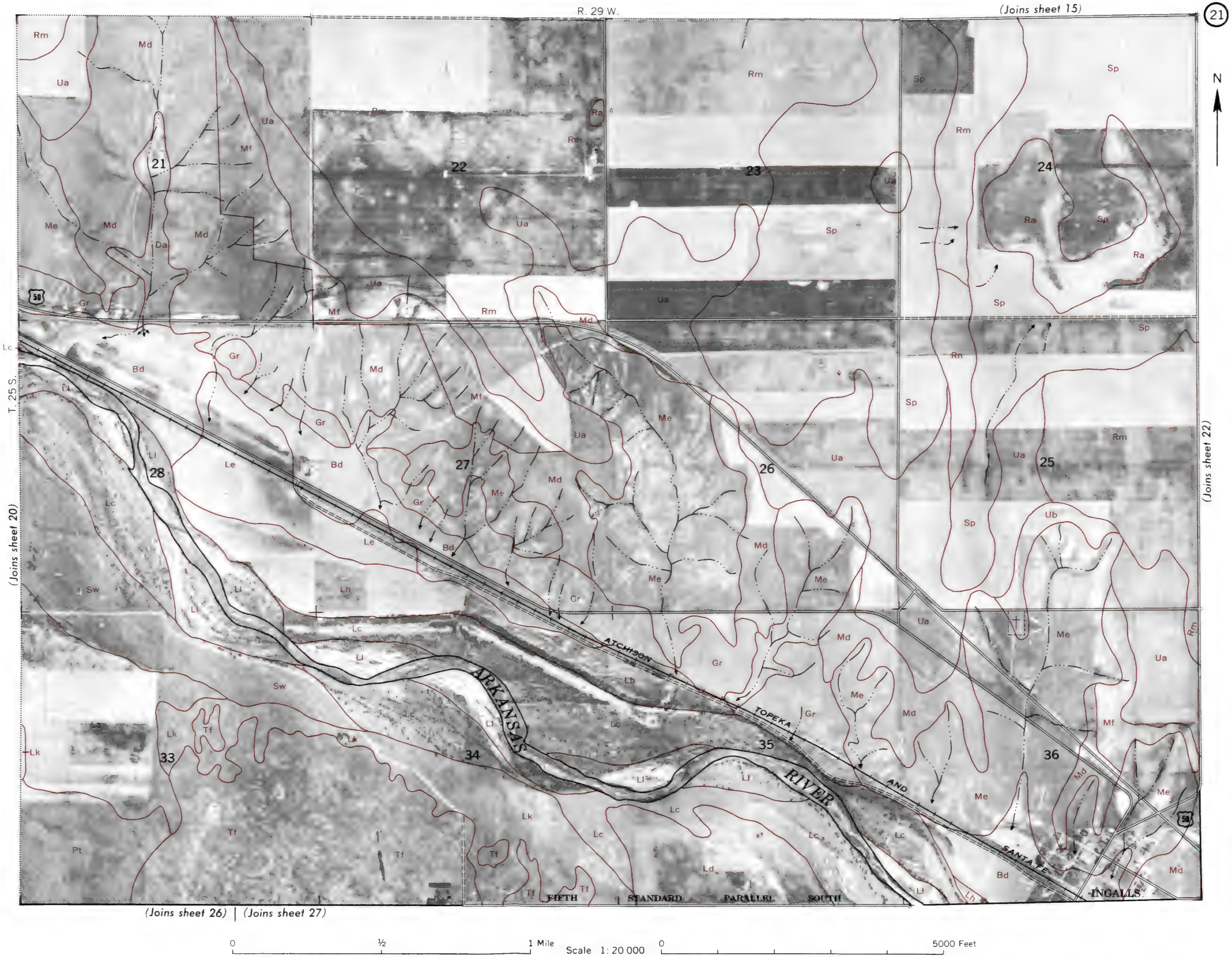
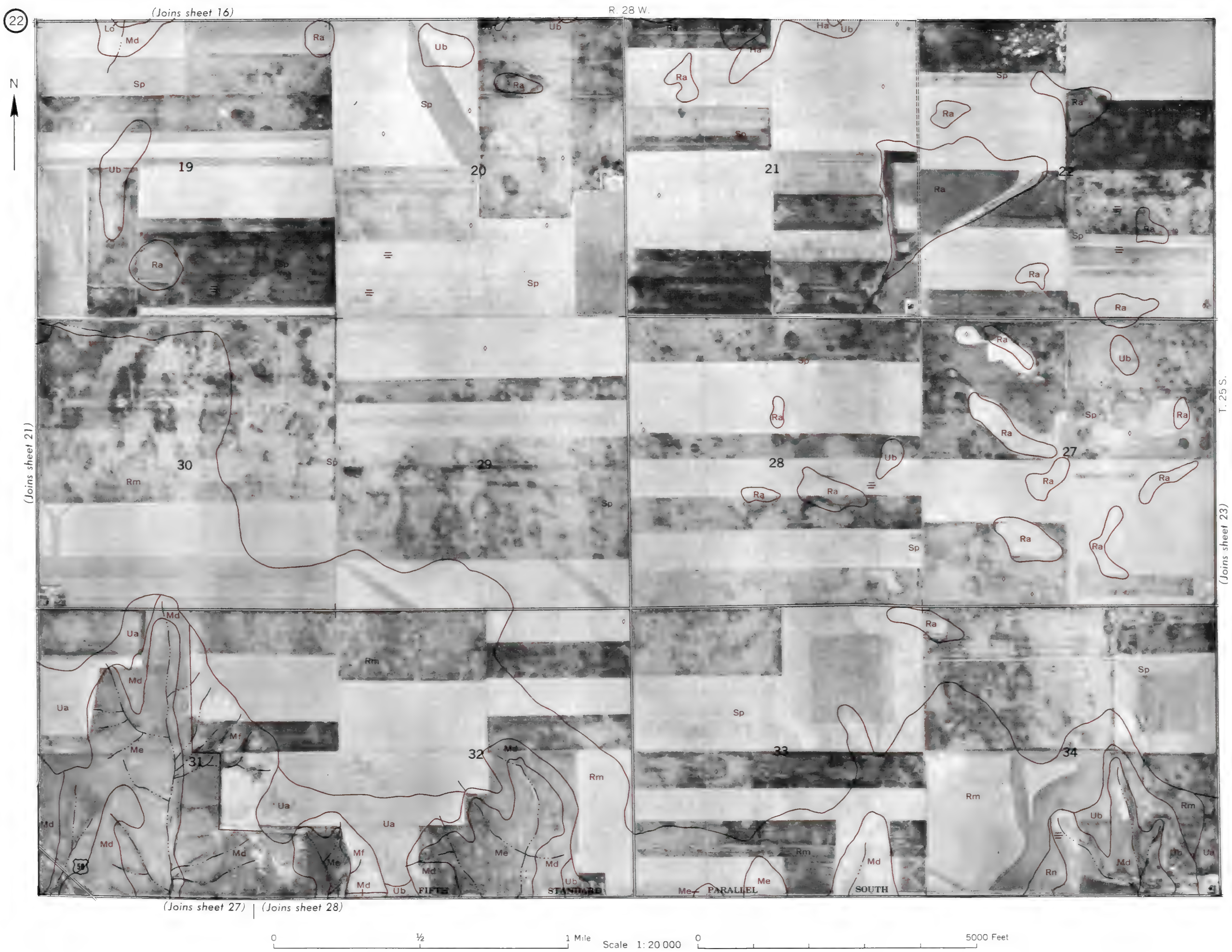
32
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

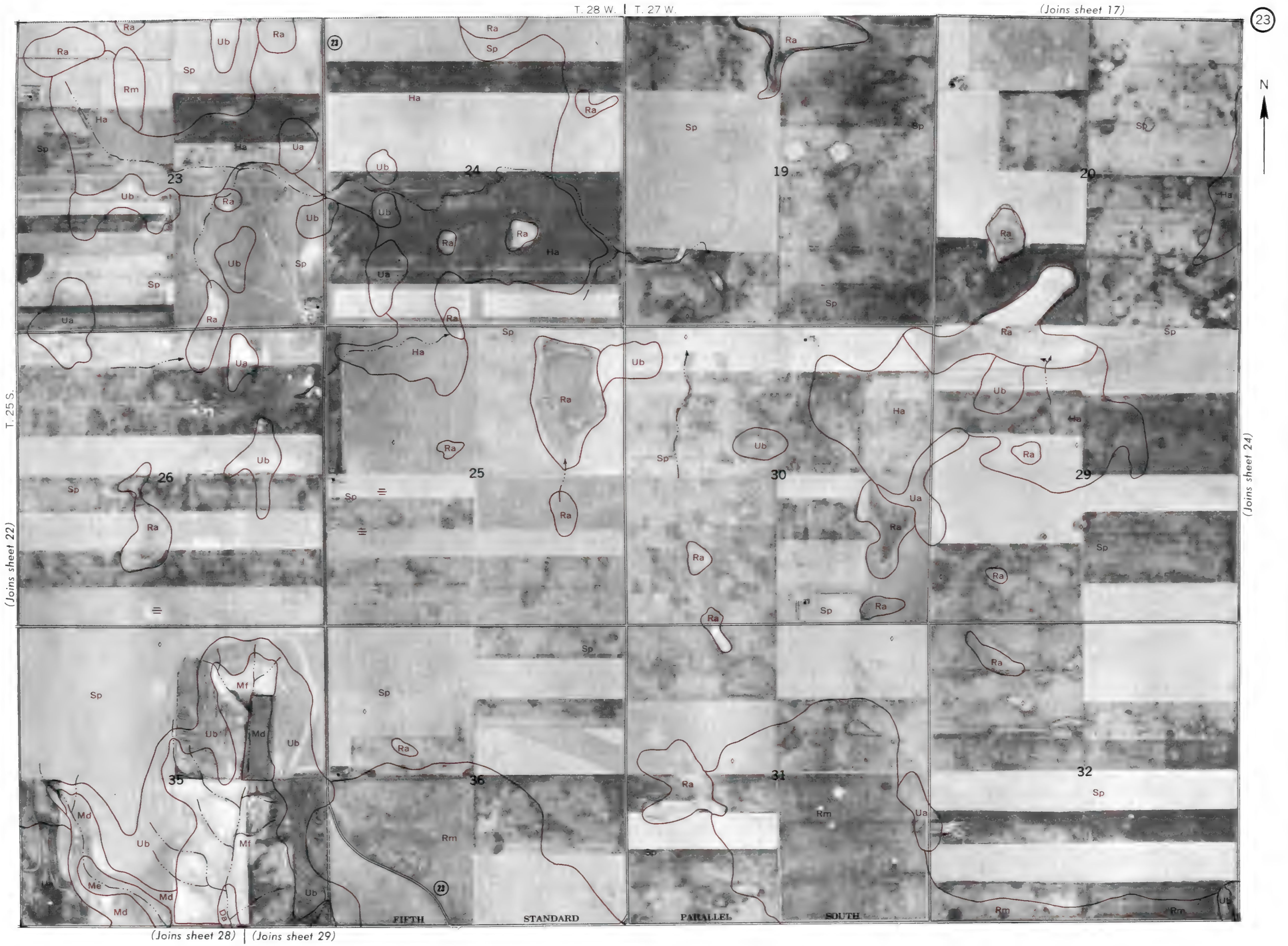



This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


22
(Joins sheet 16)
R. 28 W.
N
(Joins sheet 21)
(Joins sheet 23)
T. 25 S.
19
20
21
22
30
29
28
27
31
32
33
34
Lo
Md
Ra
Ub
Sp
Ha
Rm
Ua
Me
Mf
Rn
FIFTH
STANDARD
PARALLEL
SOUTH
(Joins sheet 27)
(Joins sheet 28)
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

GRAY COUNTY, KANSAS — SHEET NUMBER 23




0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.

GRAY COUNTY, KANSAS — SHEET NUMBER 24

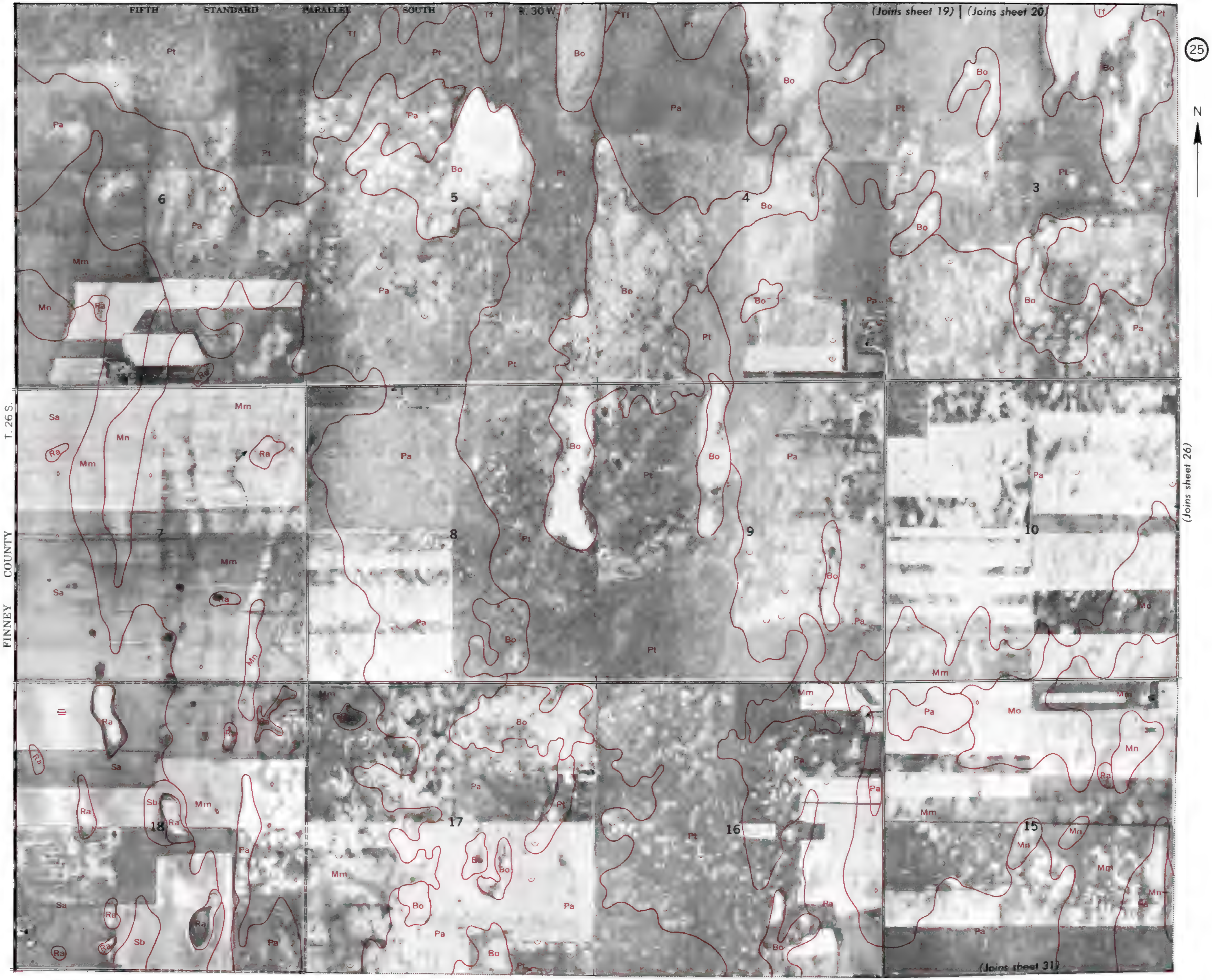

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

GRAY COUNTY, KANSAS — SHEET NUMBER 25

Scale 1:20 000

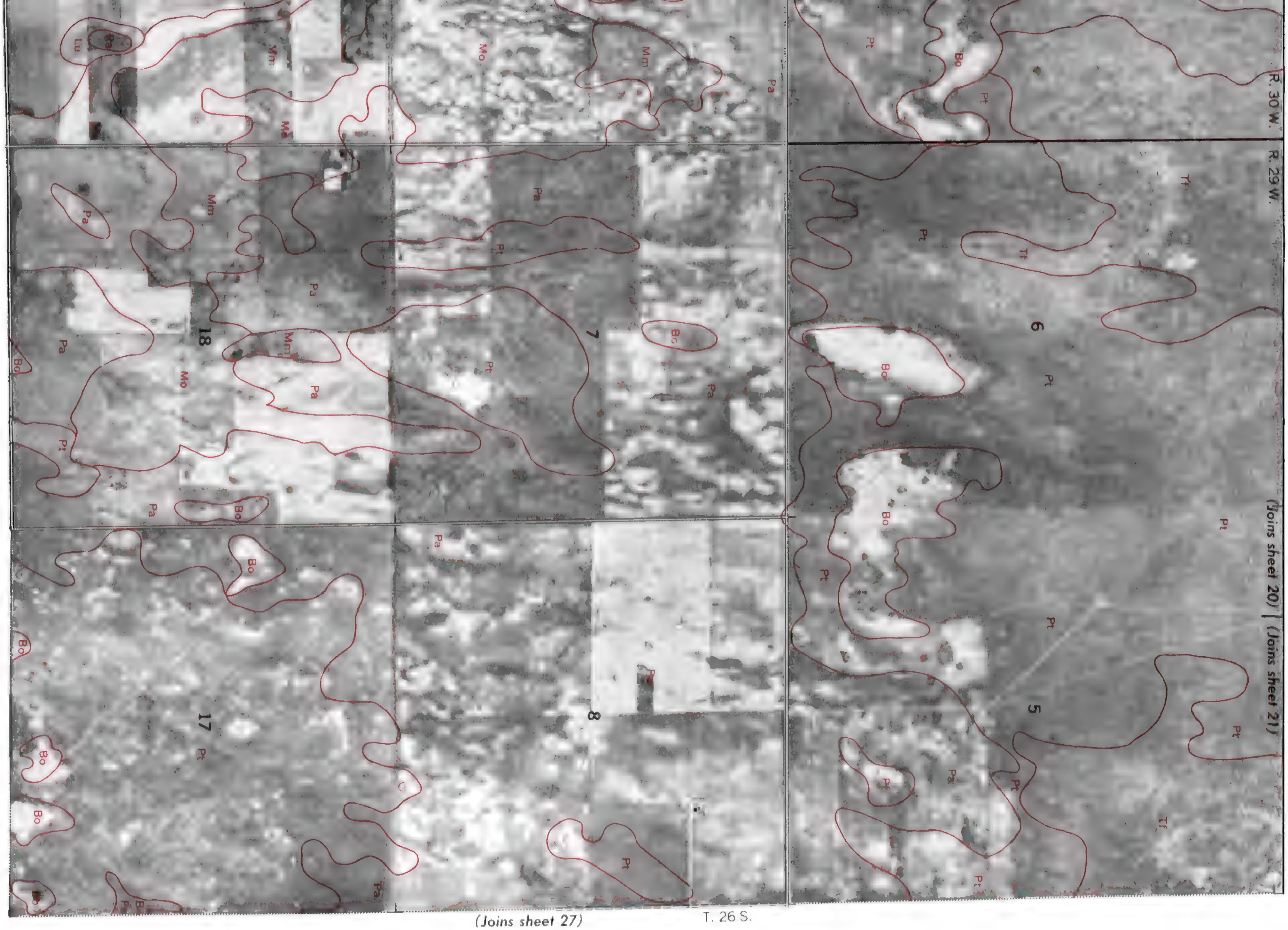
1 Mile ½ 0

5000 Feet 0




This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.




GRAY COUNTY, KANSAS — SHEET NUMBER 26

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

GRAY COUNTY, KANSAS — SHEET NUMBER 27

Scale 1:20 000

1 Mile ½ 0

5000 Feet 0


GRAY COUNTY, KANSAS — SHEET NUMBER 28

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite

GRAY COUNTY, KANSAS — SHEET NUMBER 29

Scale 1:20 000

5000 Feet

1 Mile

½

0

(30)

(Joins sheet 24)

R. 27 W.


(Joins sheet 29)

T. 26 S.

FORD COUNTY

(Joins sheet 36)

GRAY COUNTY, KANSAS — SHEET NUMBER 30

5000 Feet

0

Scale 1:20 000

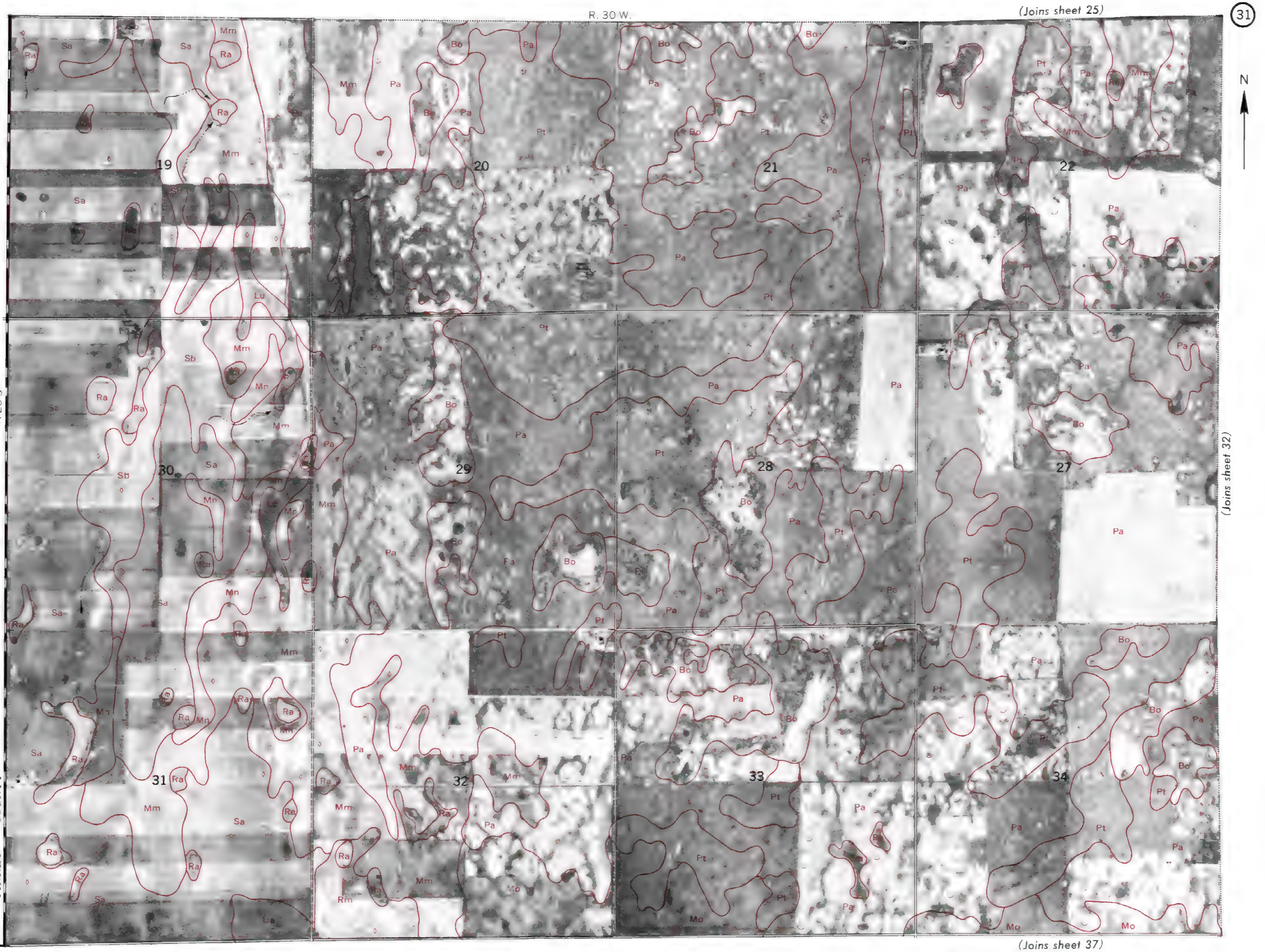
1 Mile

½

0

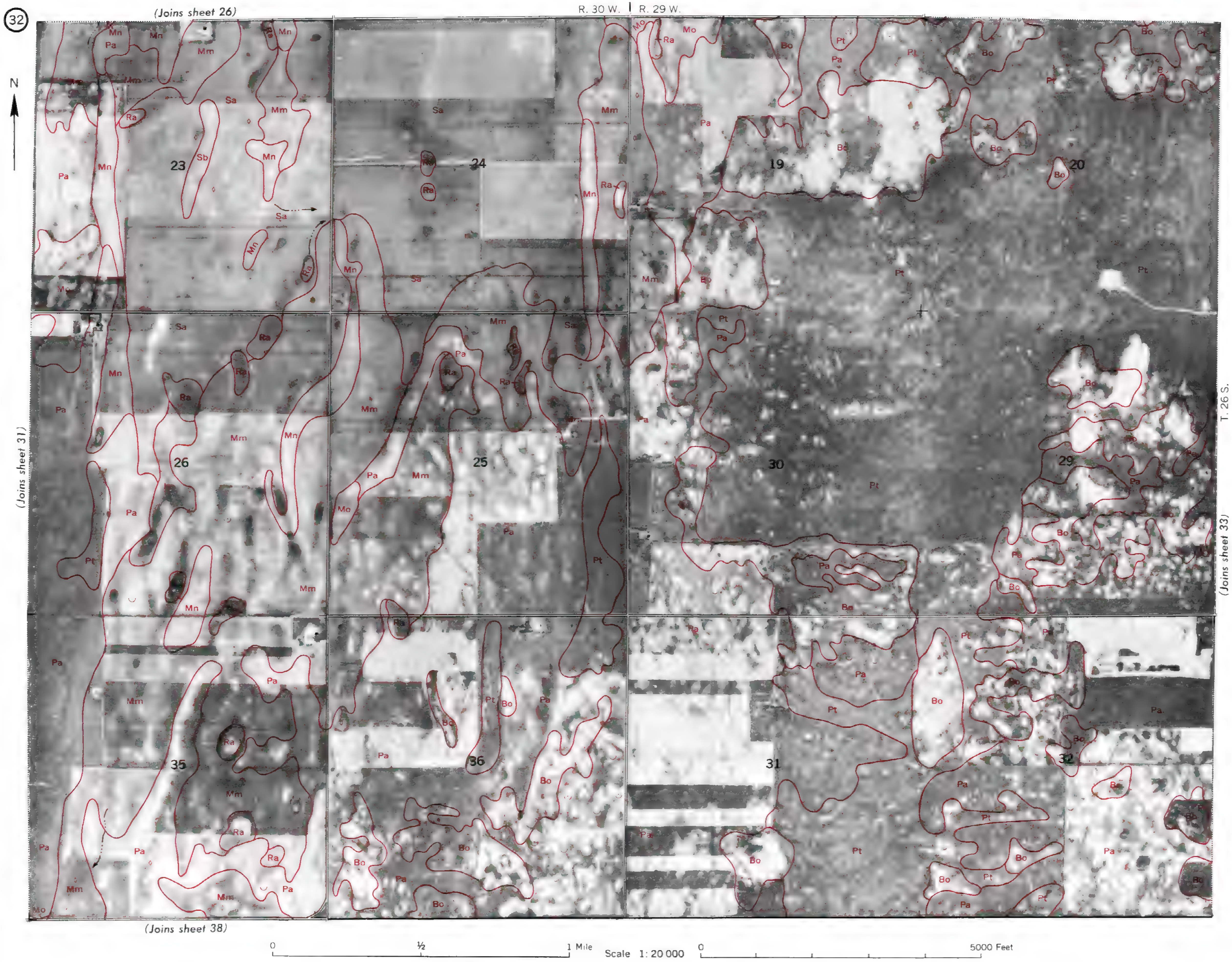
This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

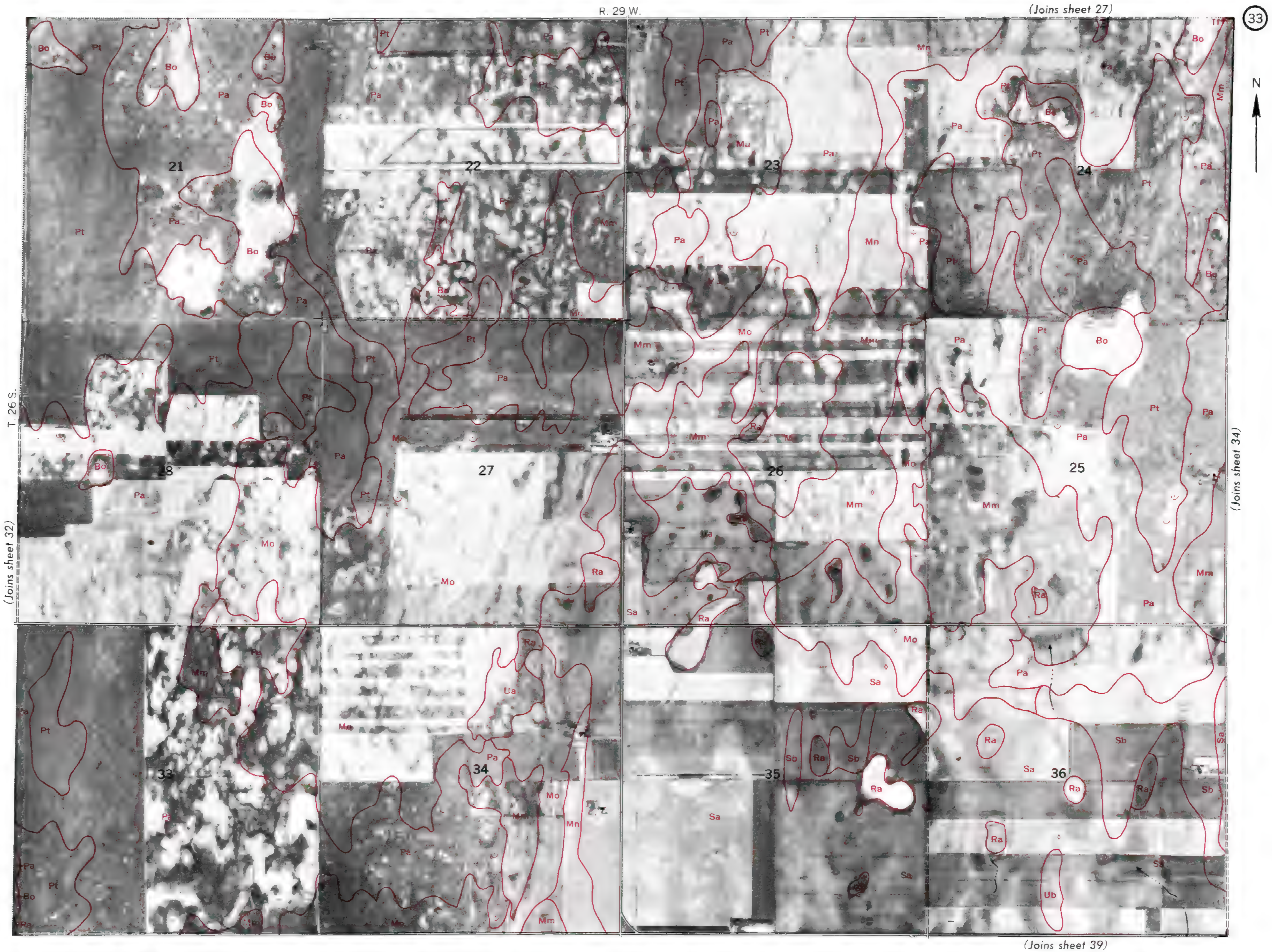



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

GRAY COUNTY, KANSAS — SHEET NUMBER 32



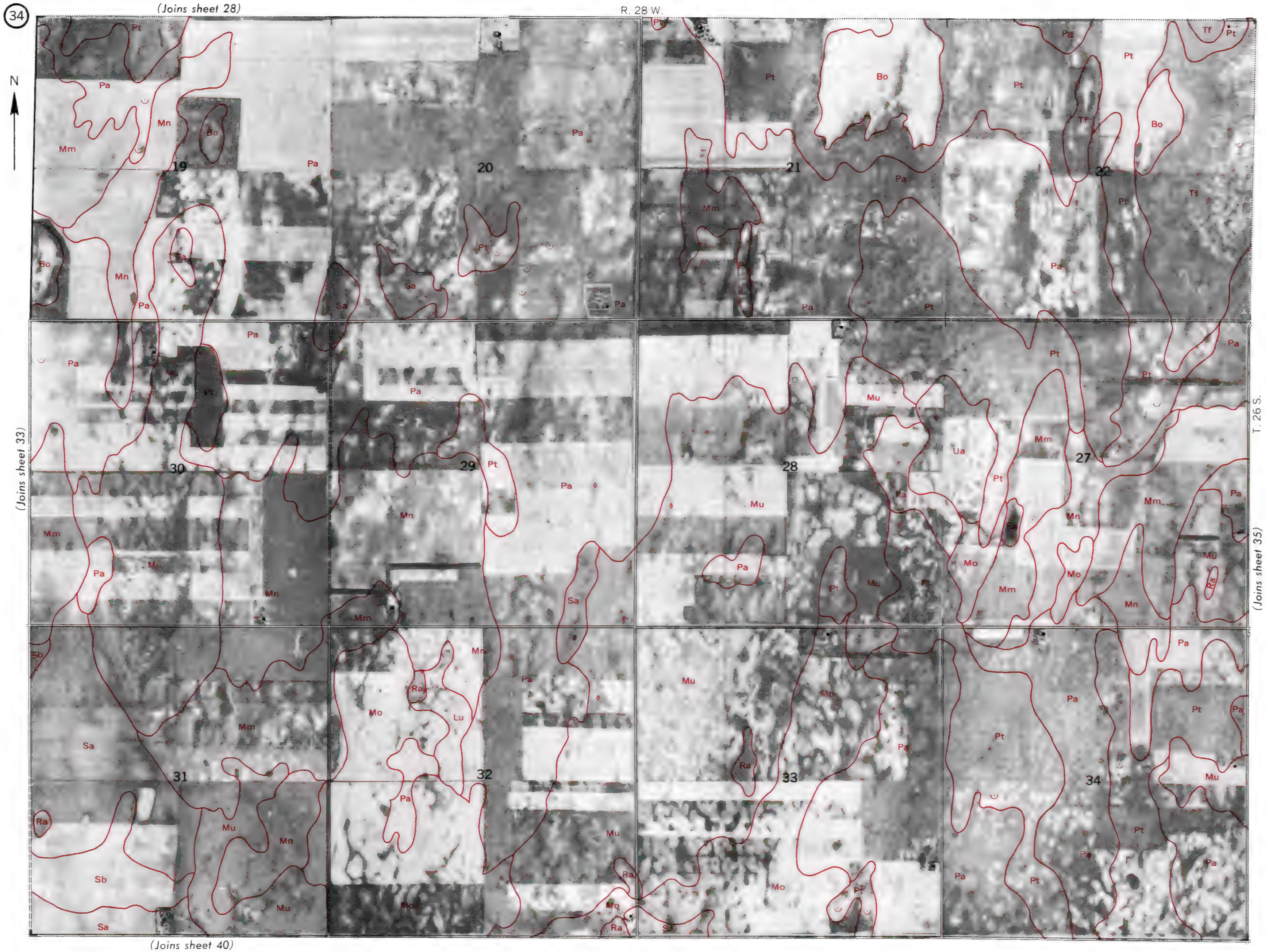
GRAY COUNTY, KANSAS — SHEET NUMBER 33




0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

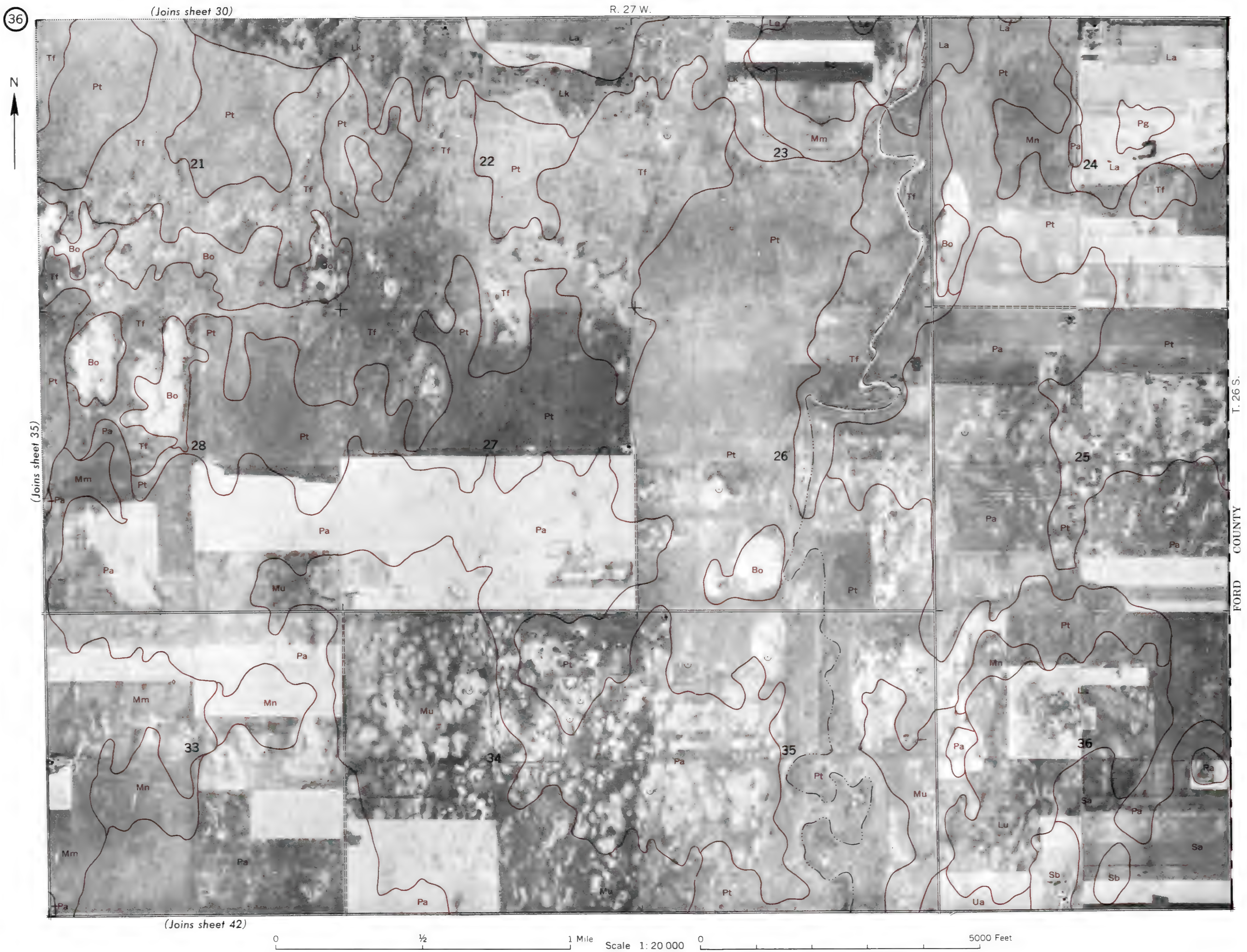
Range, township, and section corners shown on this map are indefinite.



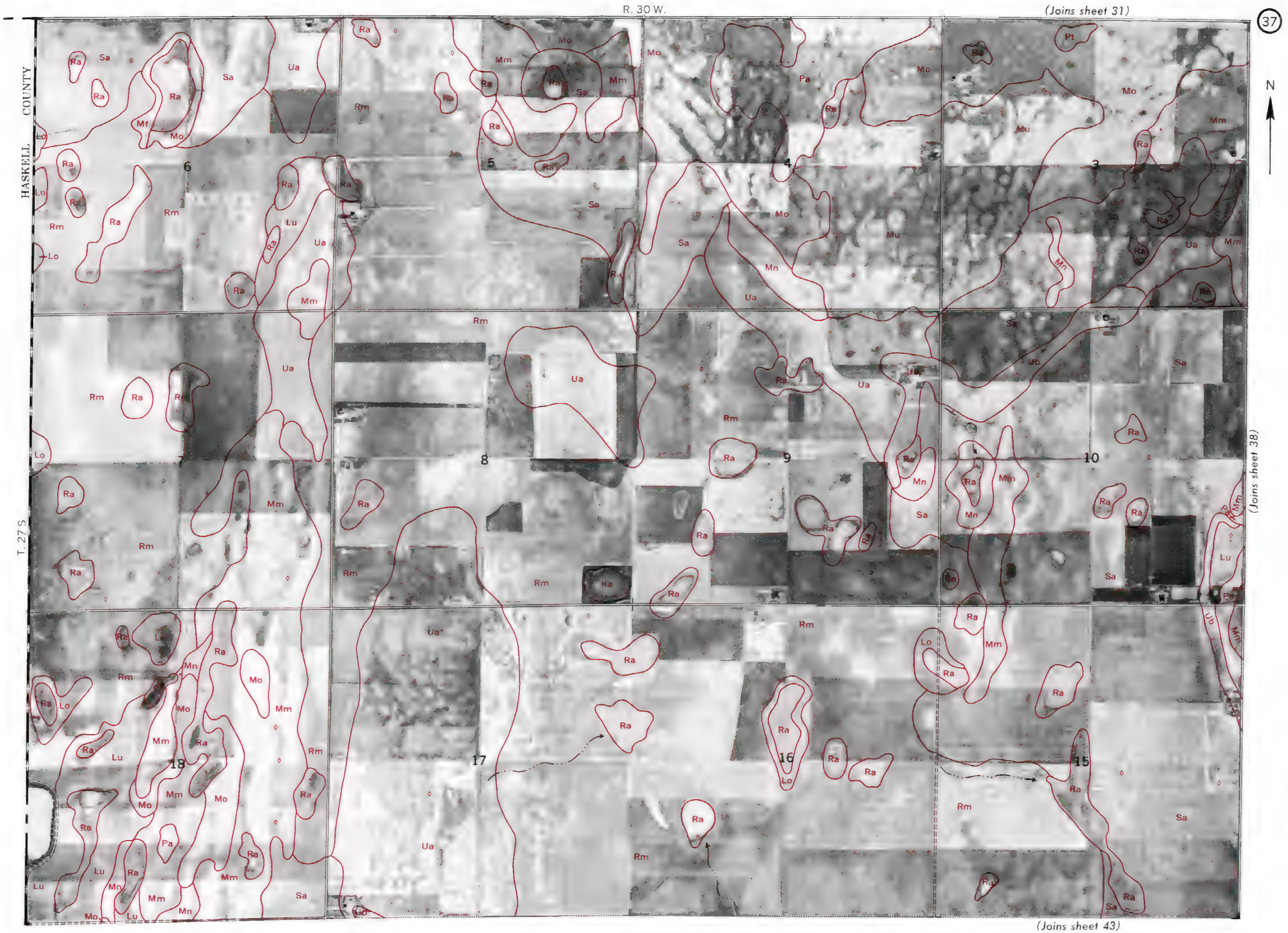

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


36
(Joins sheet 30)
R. 27 W.
N
(Joins sheet 35)
T. 26 S.
FORD COUNTY
21
22
23
24
28
27
26
25
33
34
35
36
(Joins sheet 42)
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet

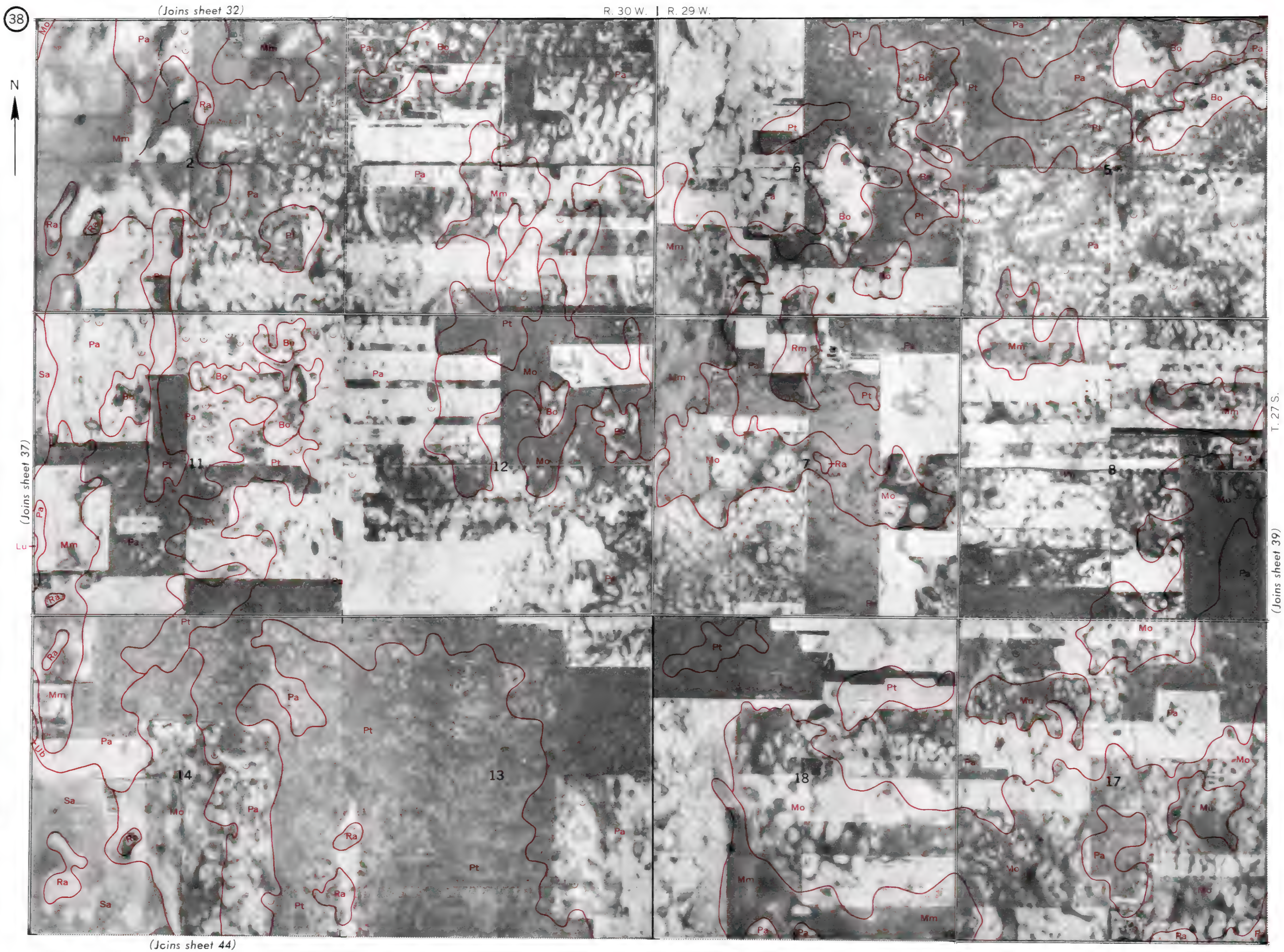
GRAY COUNTY, KANSAS — SHEET NUMBER 37




0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.

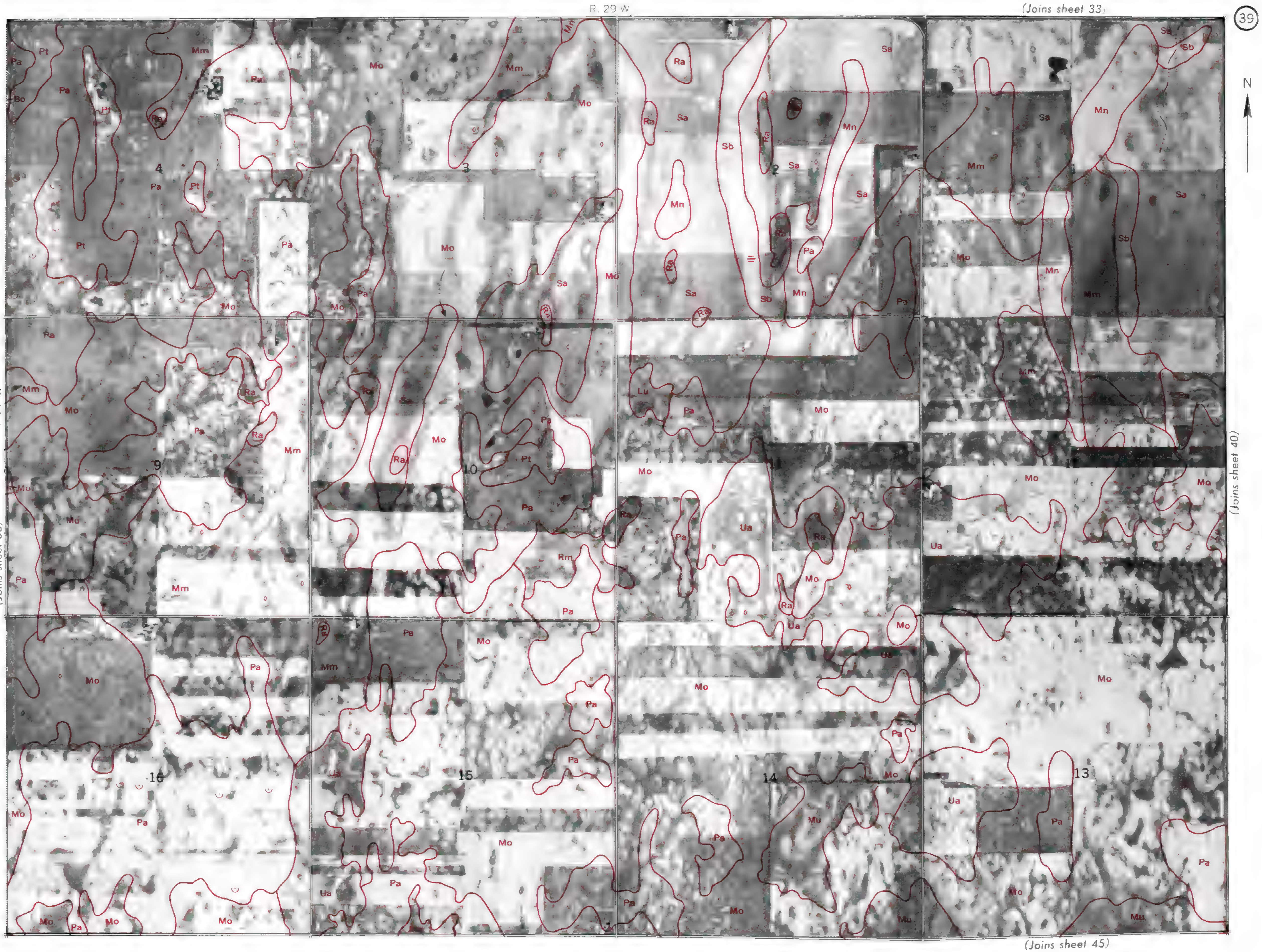



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

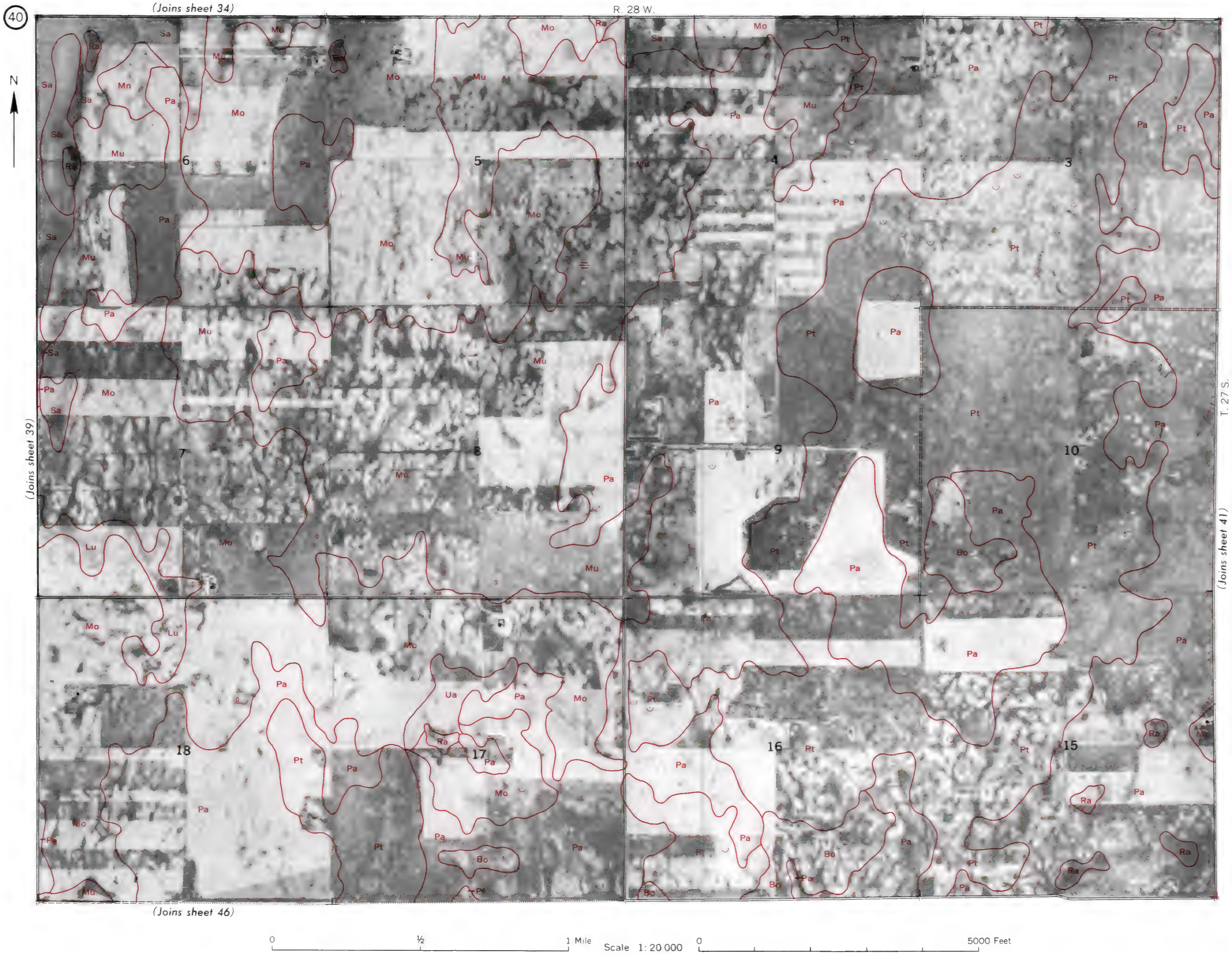
GRAY COUNTY, KANSAS — SHEET NUMBER 39

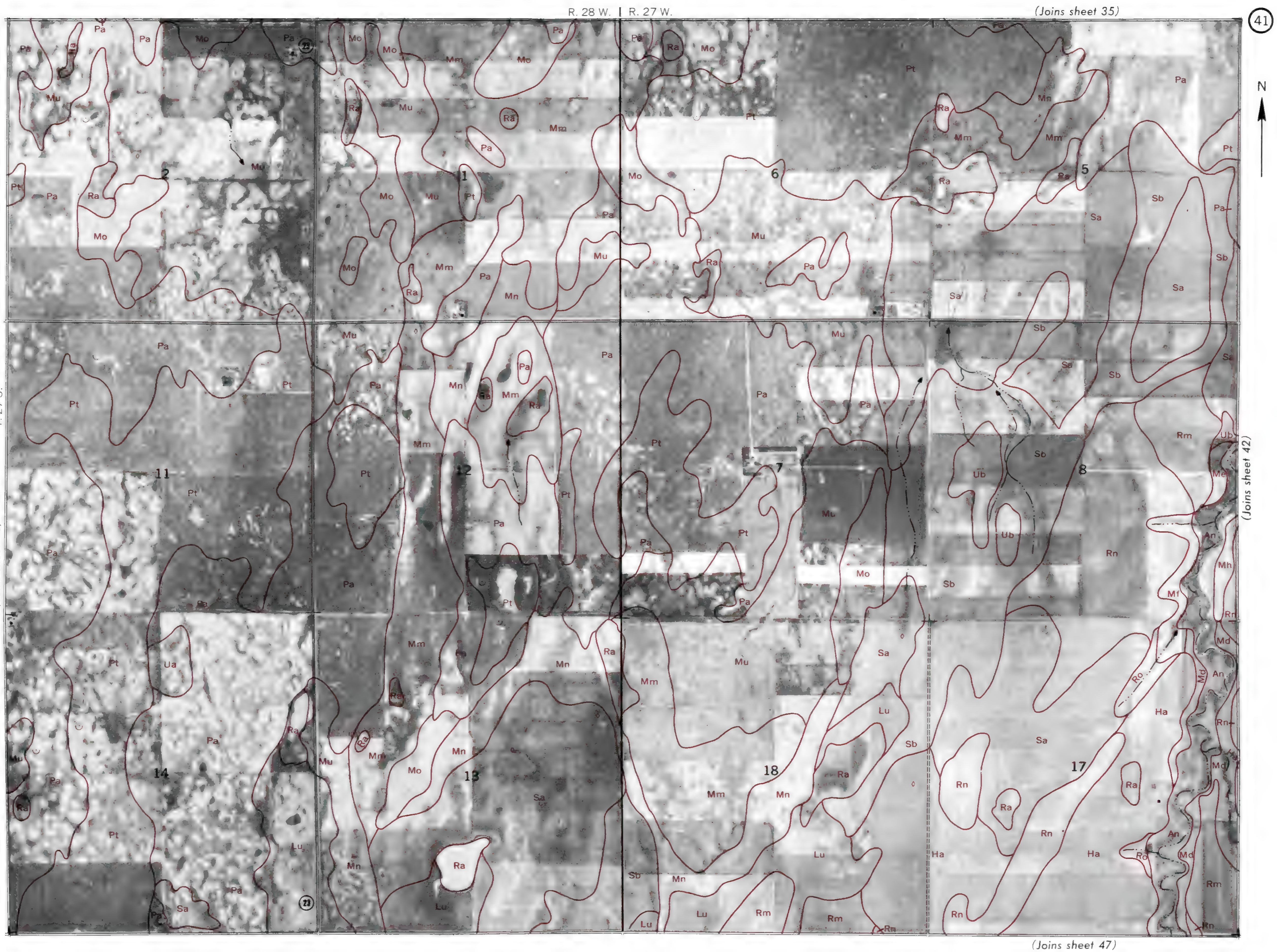
This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.




0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


40
(Joins sheet 34)
R. 28 W.
N
(Joins sheet 39)
(Joins sheet 41)
T. 27 S.
(Joins sheet 46)
6
5
4
3
7
8
9
10
18
17
16
15
Sa
Ra
Mn
Pa
Mo
Mu
Pt
Lu
Ua
Bo
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet




0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

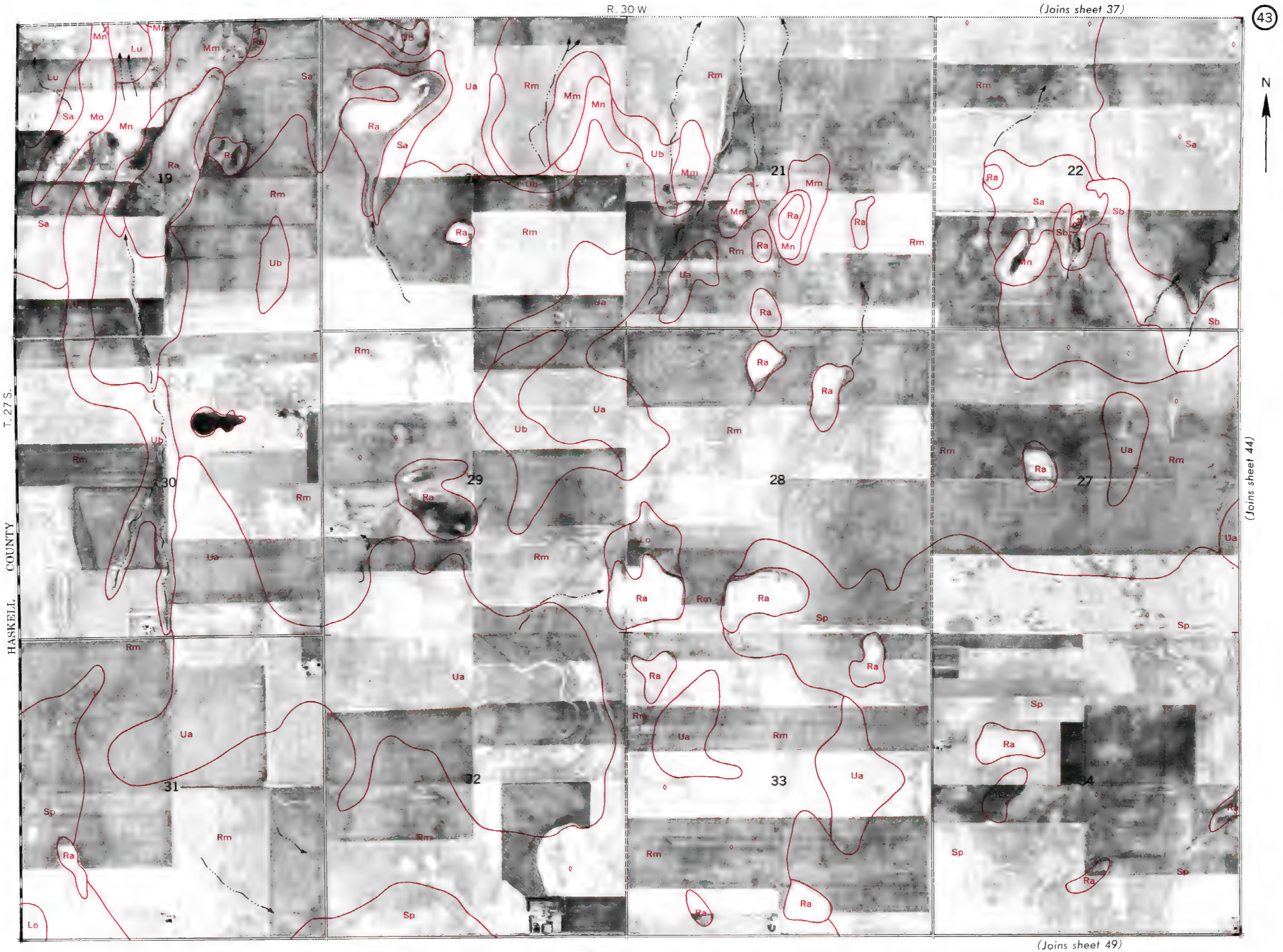
This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


42
(Joins sheet 36)
R. 27 W.
N
(Joins sheet 41)
T. 27 S.
FORD COUNTY
(Joins sheet 48)
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.




0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

44

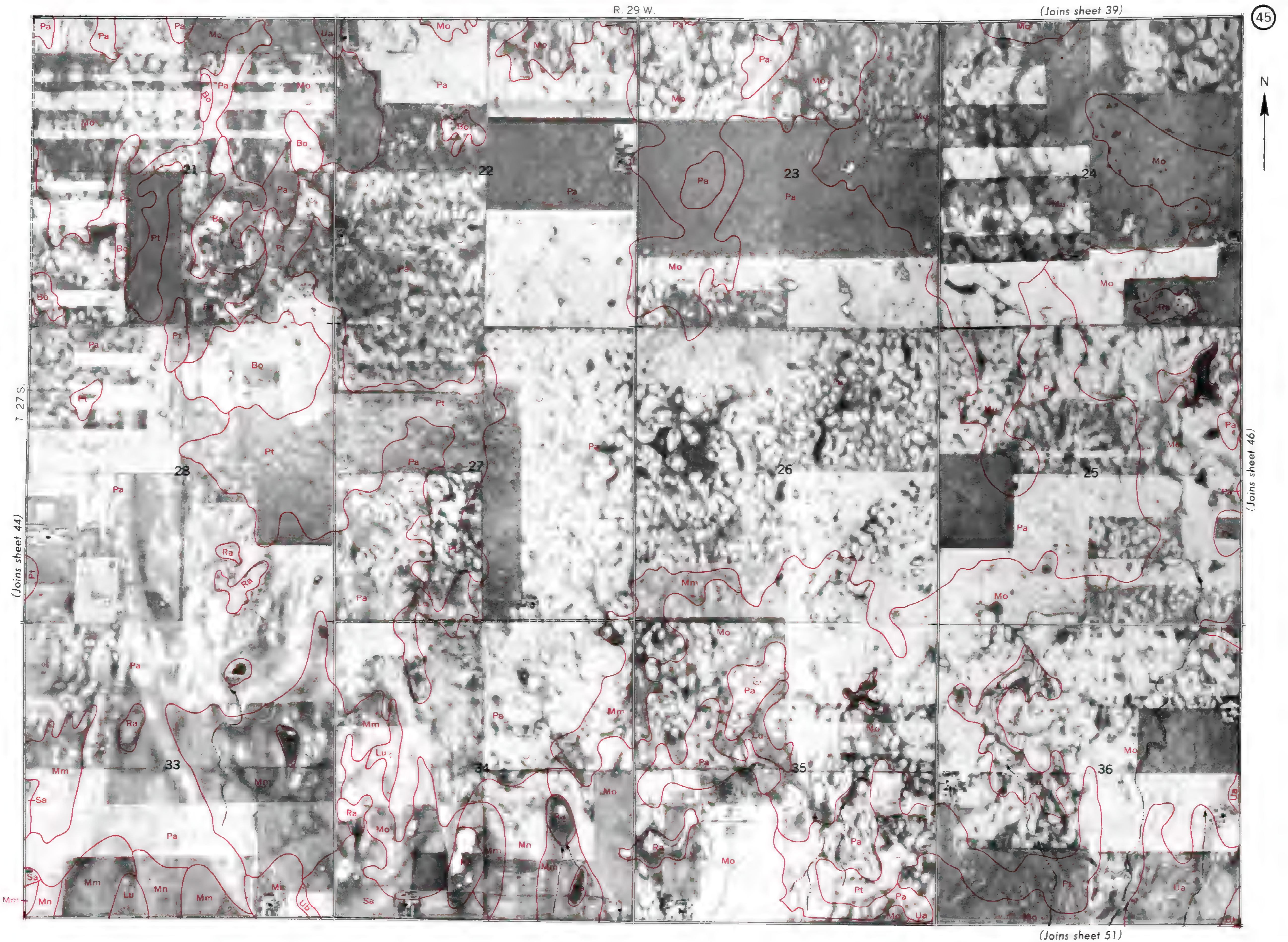
(Joins sheet 38)

R. 30 W. | R. 29 W.


(Joins sheet 50)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

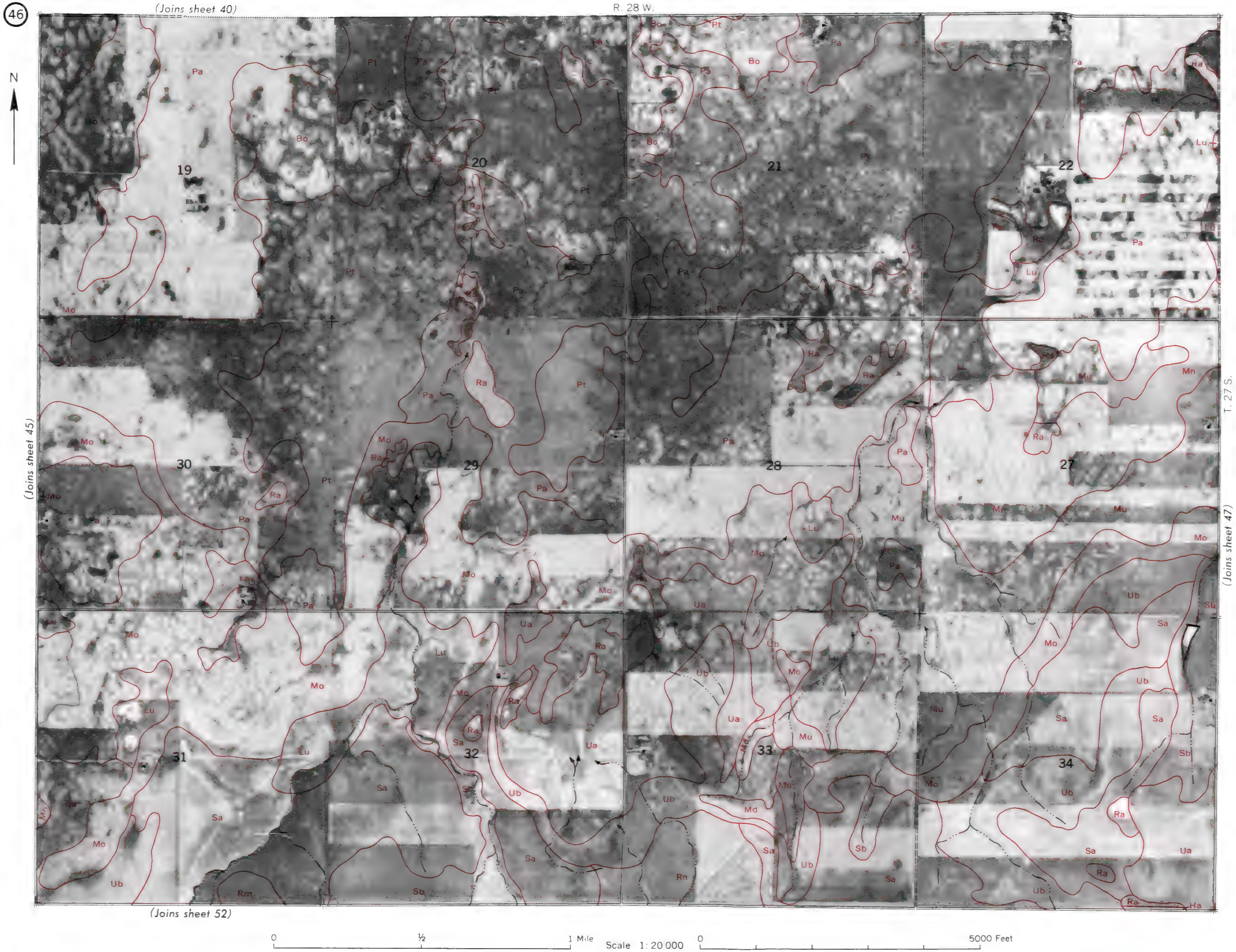
GRAY COUNTY, KANSAS — SHEET NUMBER 45

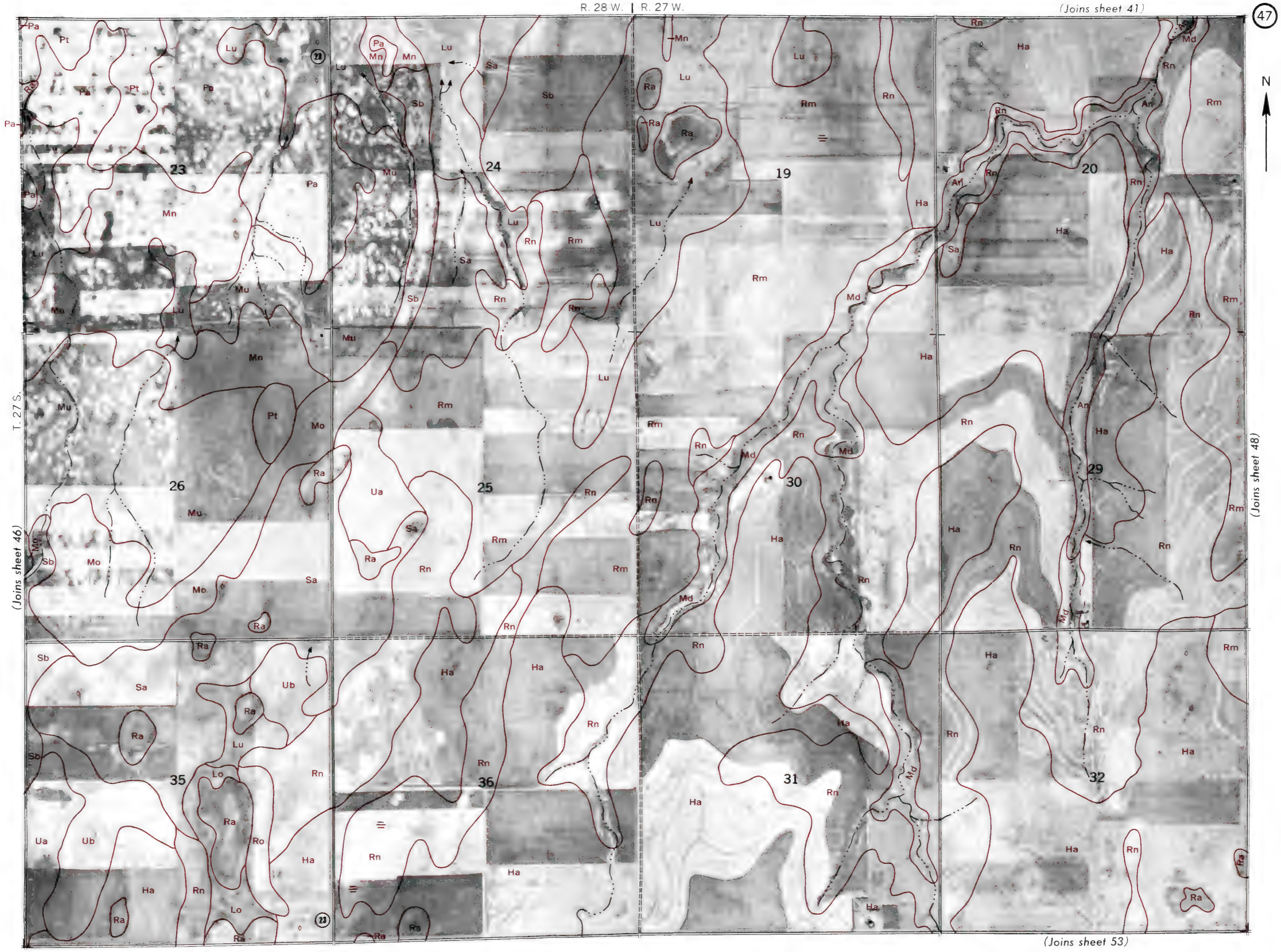



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

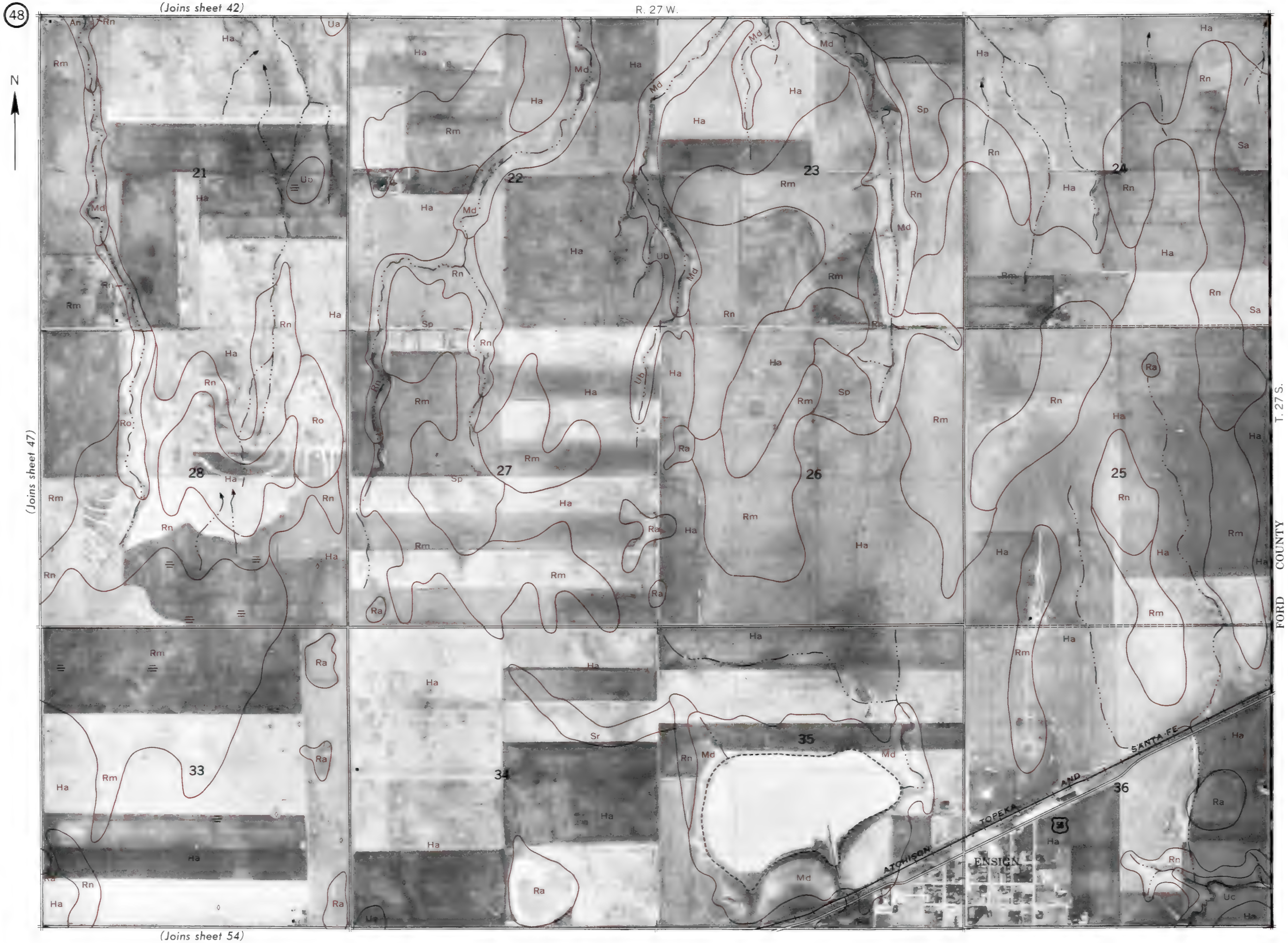

46
(Joins sheet 40)
R. 28 W.
N
(Joins sheet 45)
(Joins sheet 47)
T. 27 S.
(Joins sheet 52)
19
20
21
22
30
29
28
27
31
32
33
34
0
½
1 Mile
Scale 1:20 000
0
5000 Feet




This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

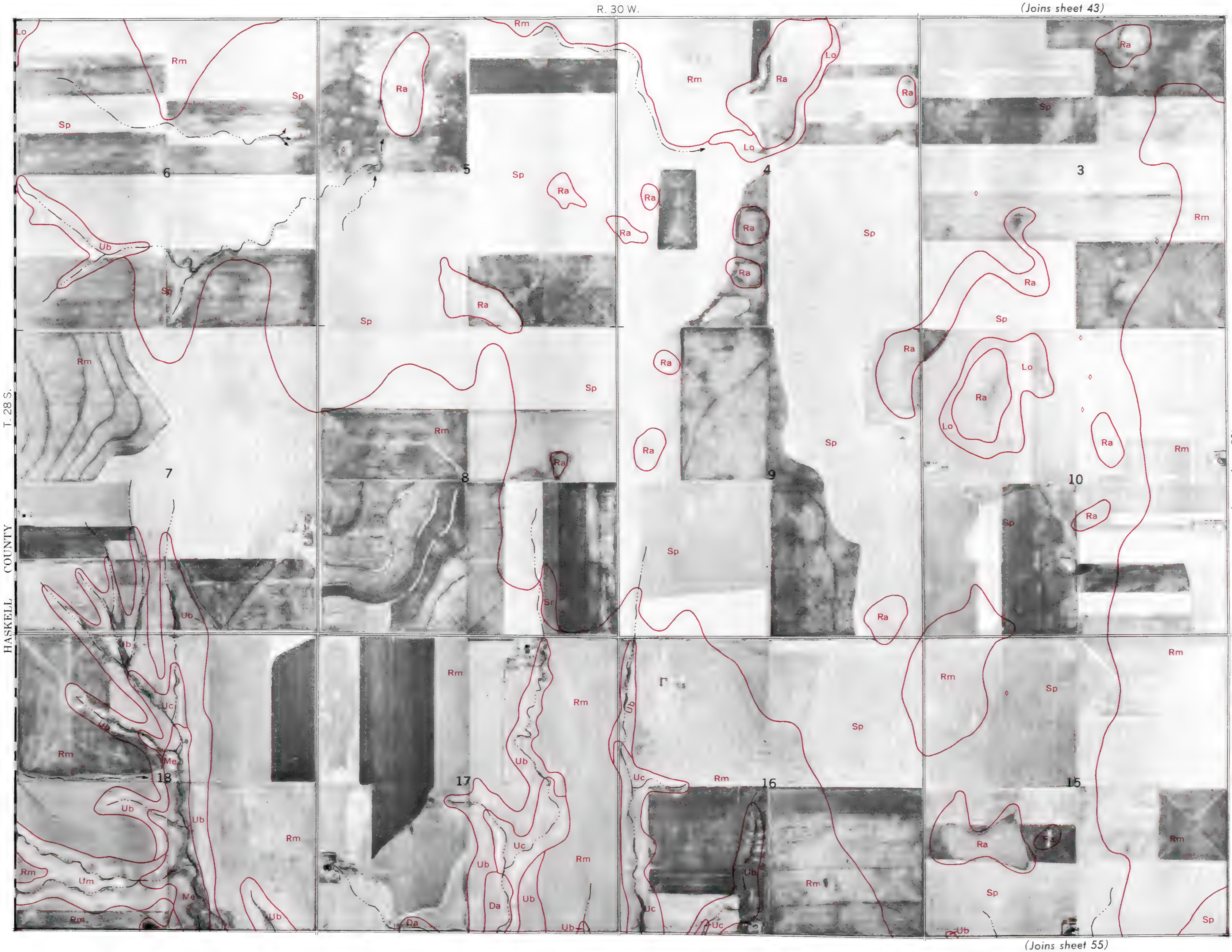
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



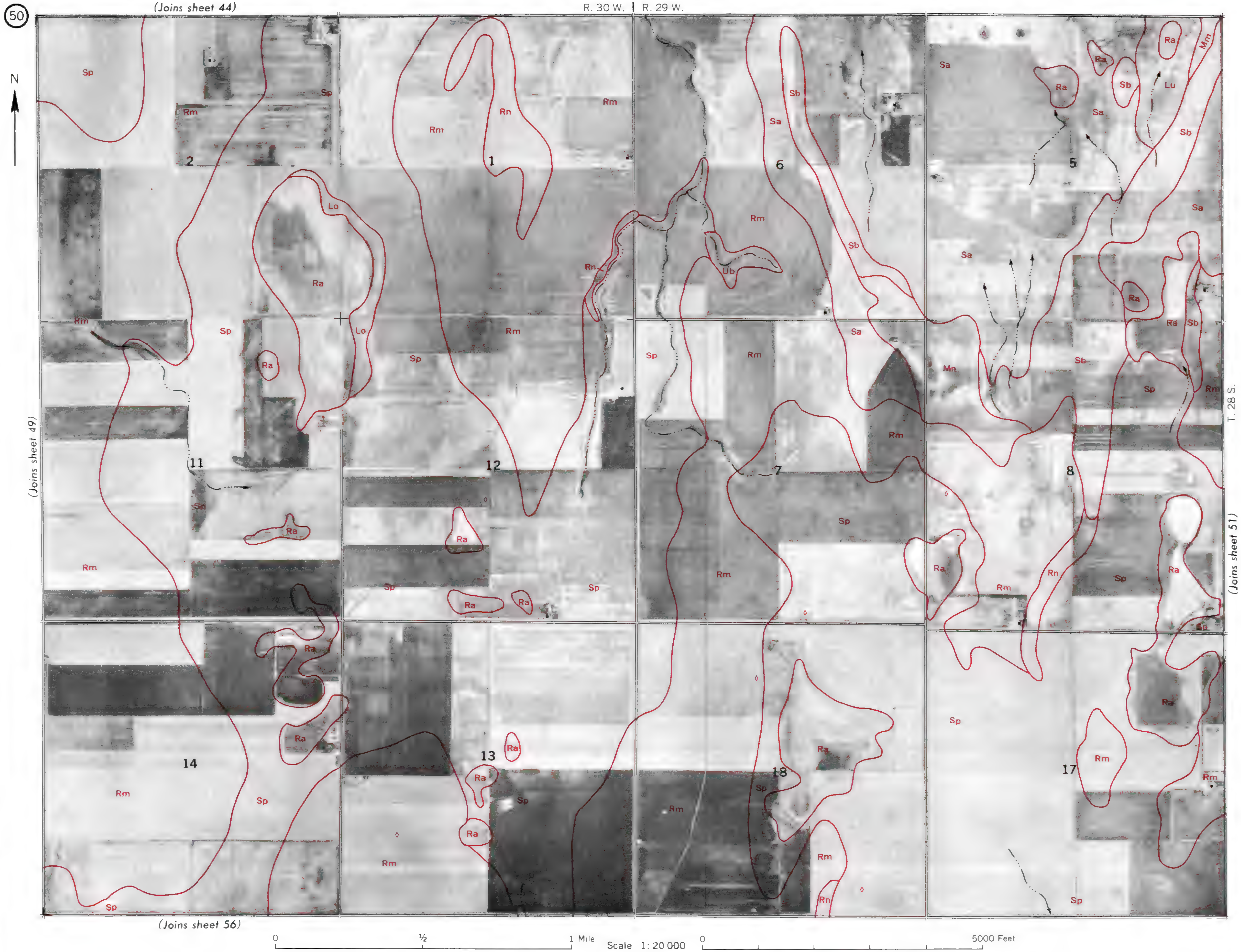

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

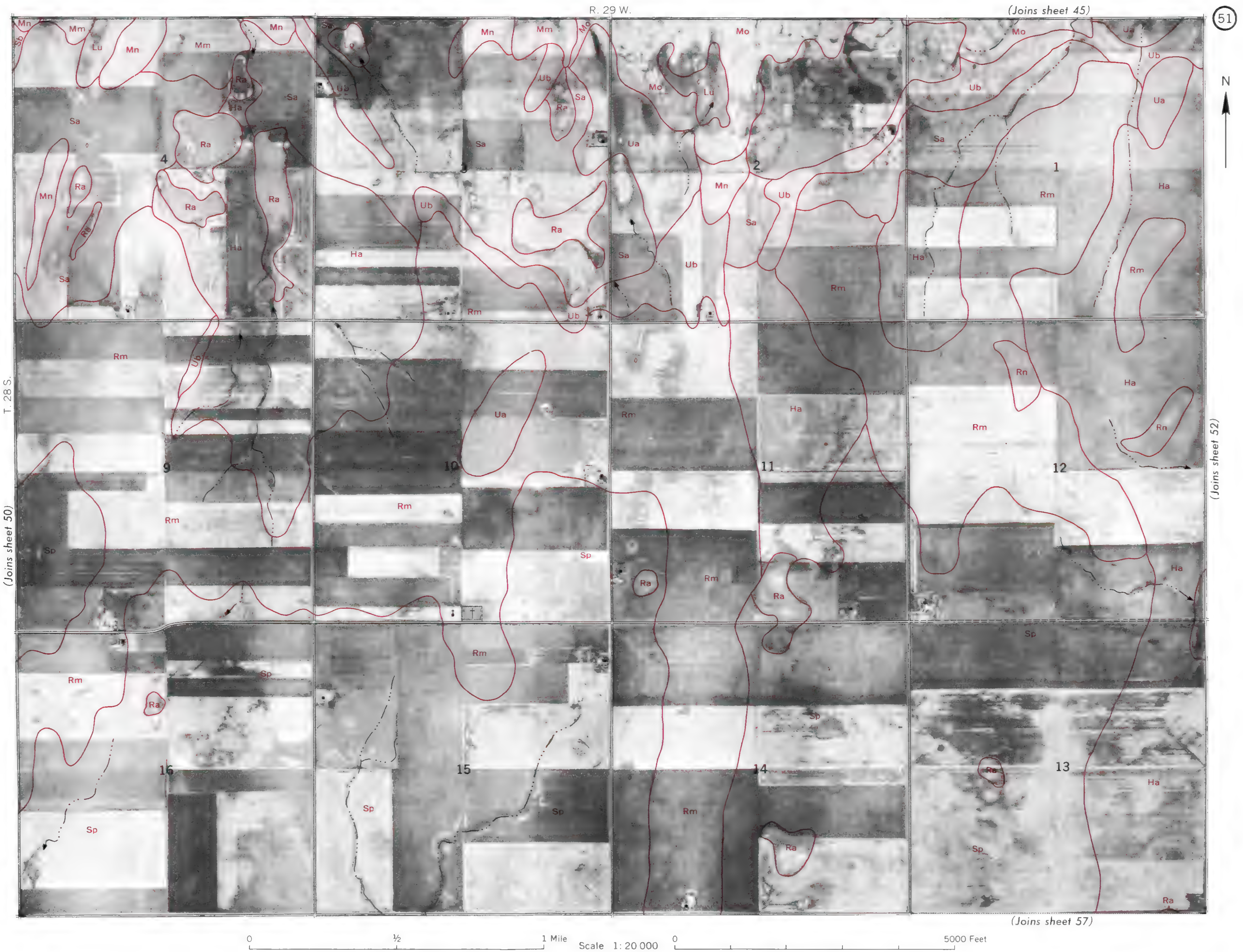
Range, township, and section corners shown on this map are indefinite.




0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


50
(Joins sheet 44)
R. 30 W. | R. 29 W.
N
(Joins sheet 49)
(Joins sheet 51)
T. 28 S.
(Joins sheet 56)
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet

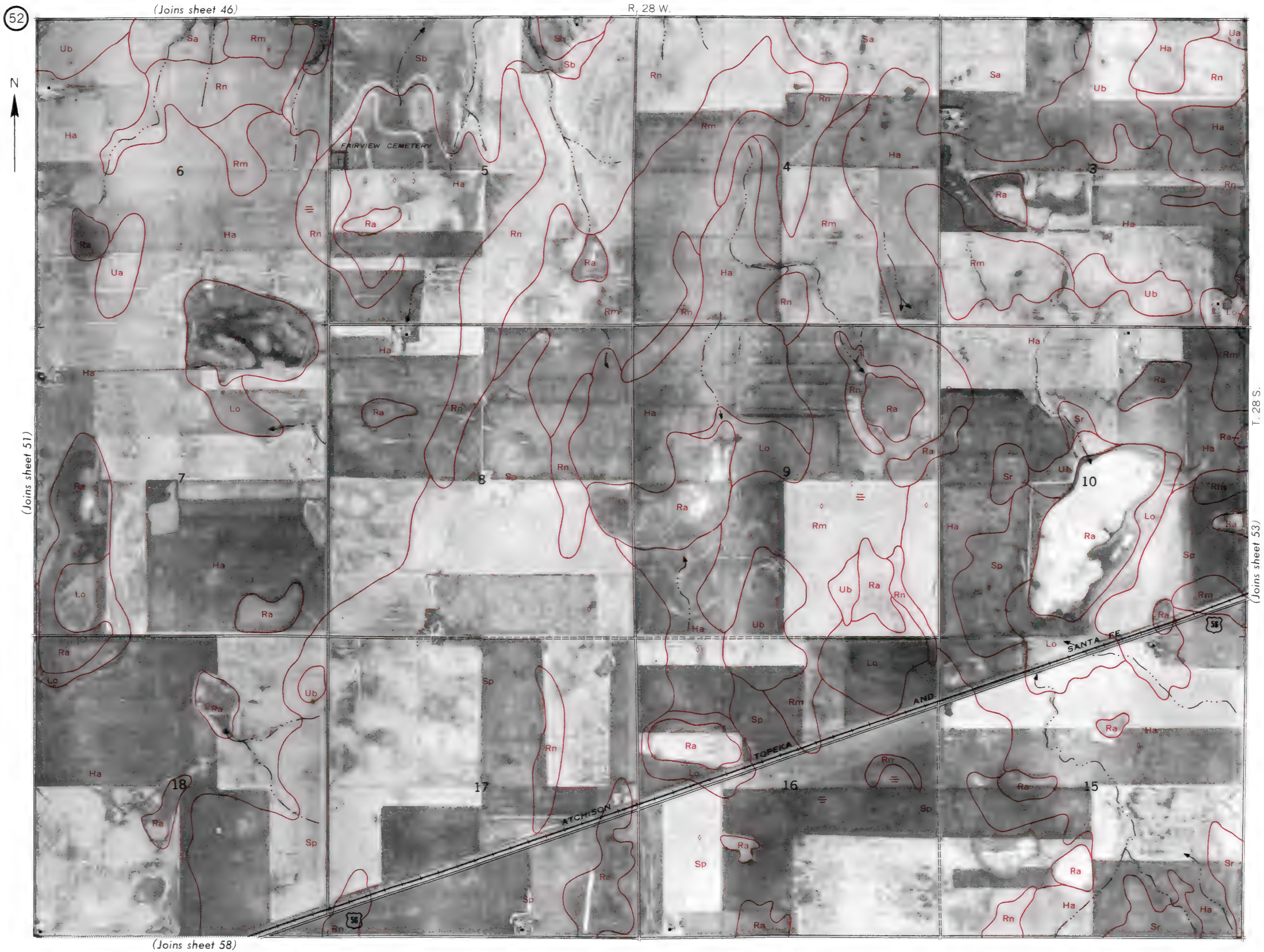
GRAY COUNTY, KANSAS — SHEET NUMBER 51




This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

GRAY COUNTY, KANSAS — SHEET NUMBER 52




Scale 1: 20 000

0 ½ 1 Mile

0 5000 Feet

R. 28 W. | R. 27 W.

(Joins sheet 47)

53


(Joins sheet 52)

(Joins sheet 54)

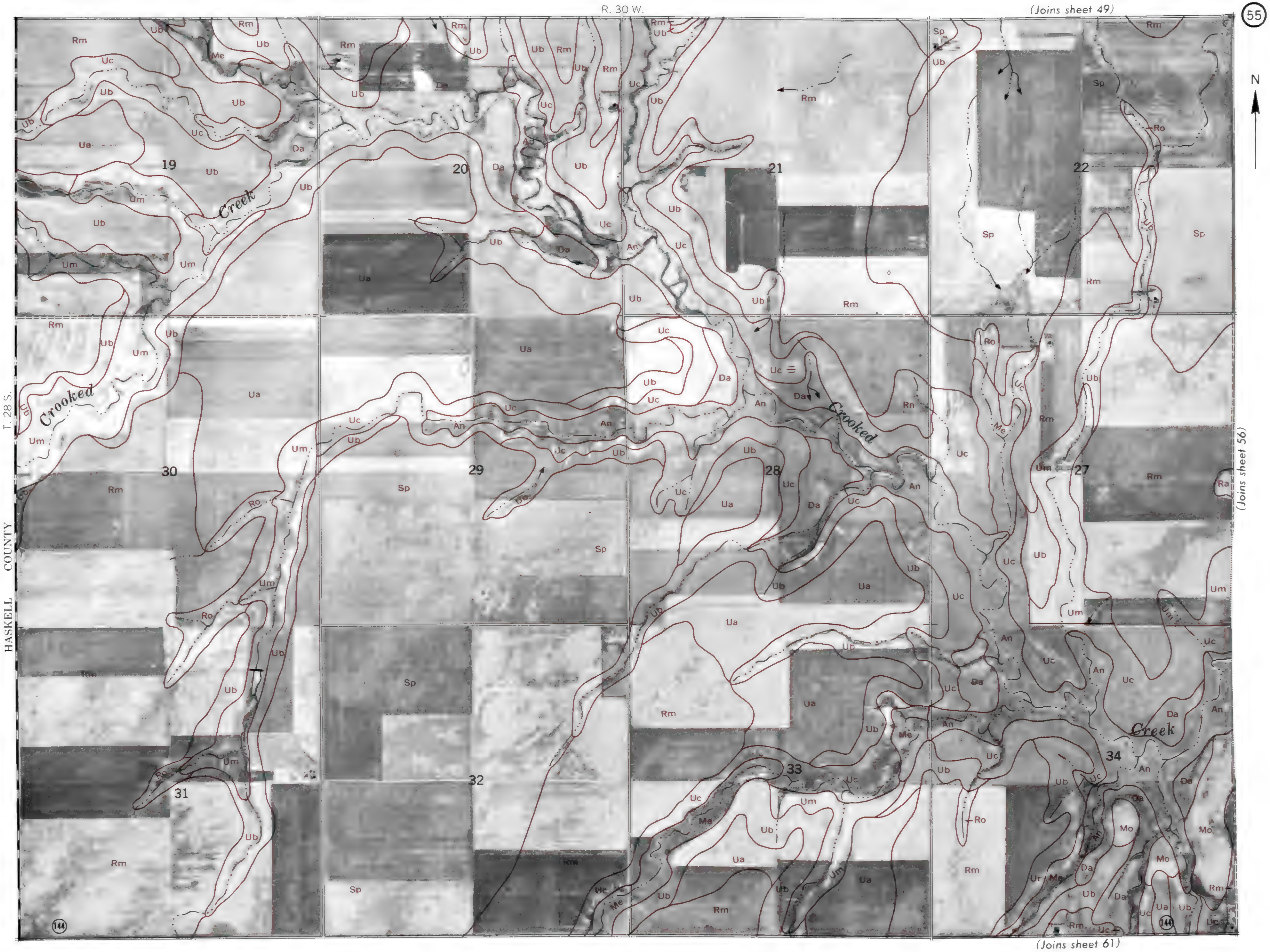
(Joins sheet 59)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.

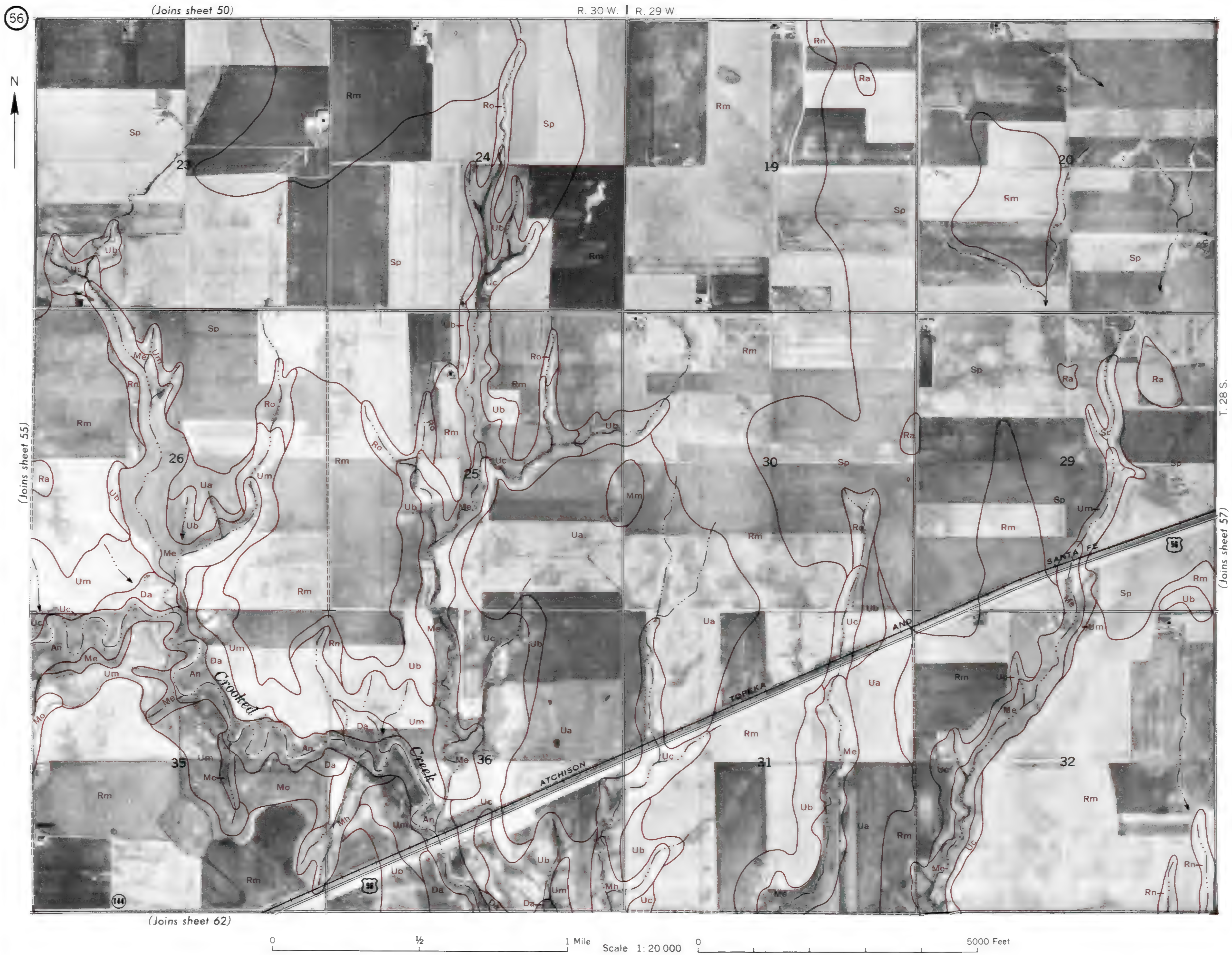

54
(Joins sheet 48)
R. 27 W.
N
ATCHISON TOPEKA AND SANTA FE
(Joins sheet 53)
T. 28 S.
FORD COUNTY
ENSIGN CEMETERY
Ha
Ra
Ua
Sr
Ro
Rn
Me
Md
Sp
Uc
Rm
4
3
2
1
9
10
11
12
16
15
14
13
(Joins sheet 60)
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet




This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


56
(Joins sheet 50)
R. 30 W. | R. 29 W.
N
(Joins sheet 55)
(Joins sheet 57)
T. 28 S.
(Joins sheet 62)
23
24
19
20
26
25
30
29
35
36
31
32
Crooked Creek
ATCHISON TOPEKA AND SANTA FE
Sp
Rm
Ro
Rn
Ra
Ub
Uc
Ua
Um
Me
Mm
Mo
Mh
Da
An
0 ½ 1 Mile
Scale 1:20 000
0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.

R. 29 W.

(Joins sheet 51)

57

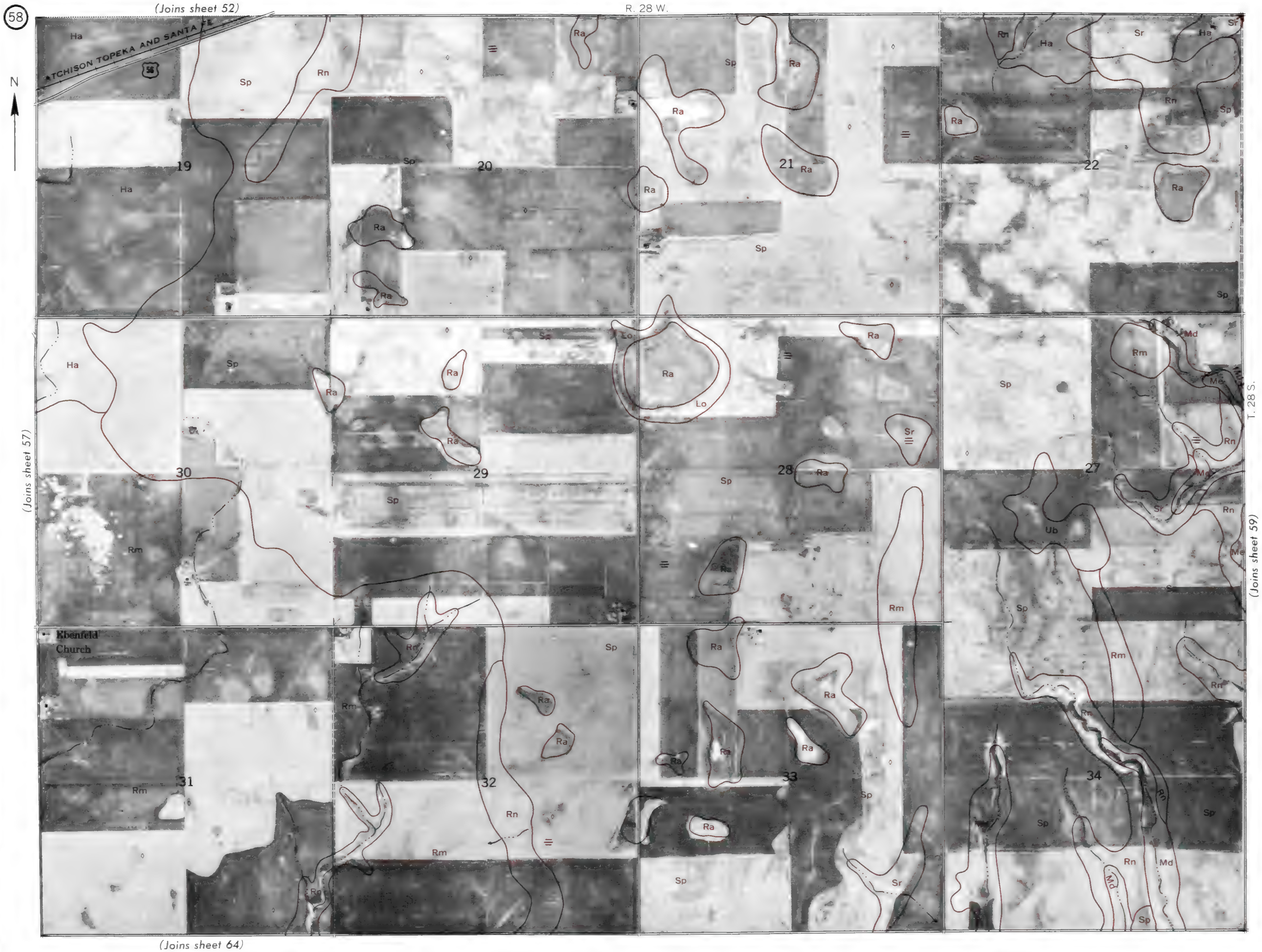
T. 28 S.

(Joins sheet 56)


(Joins sheet 58)

(Joins sheet 63)

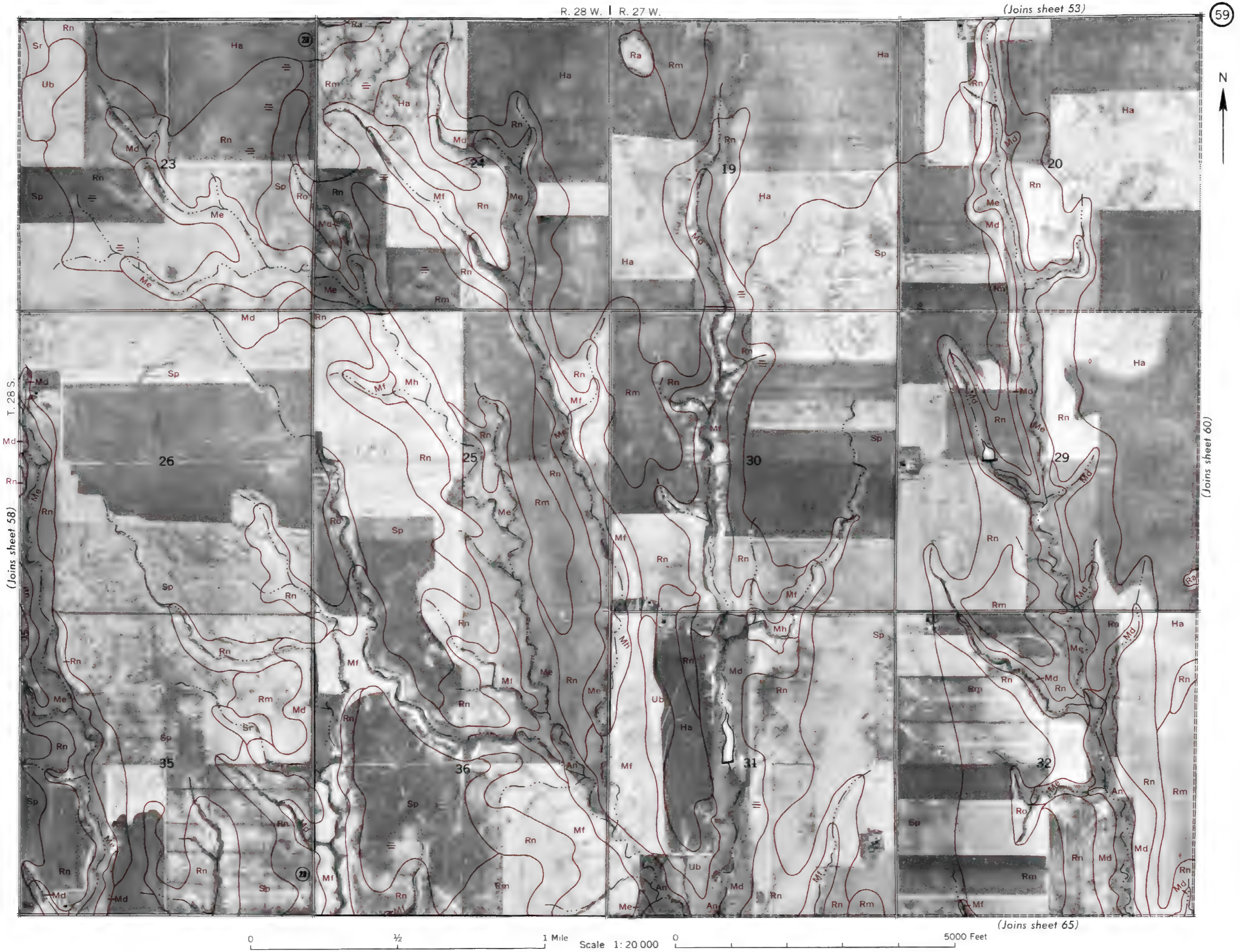
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet




0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

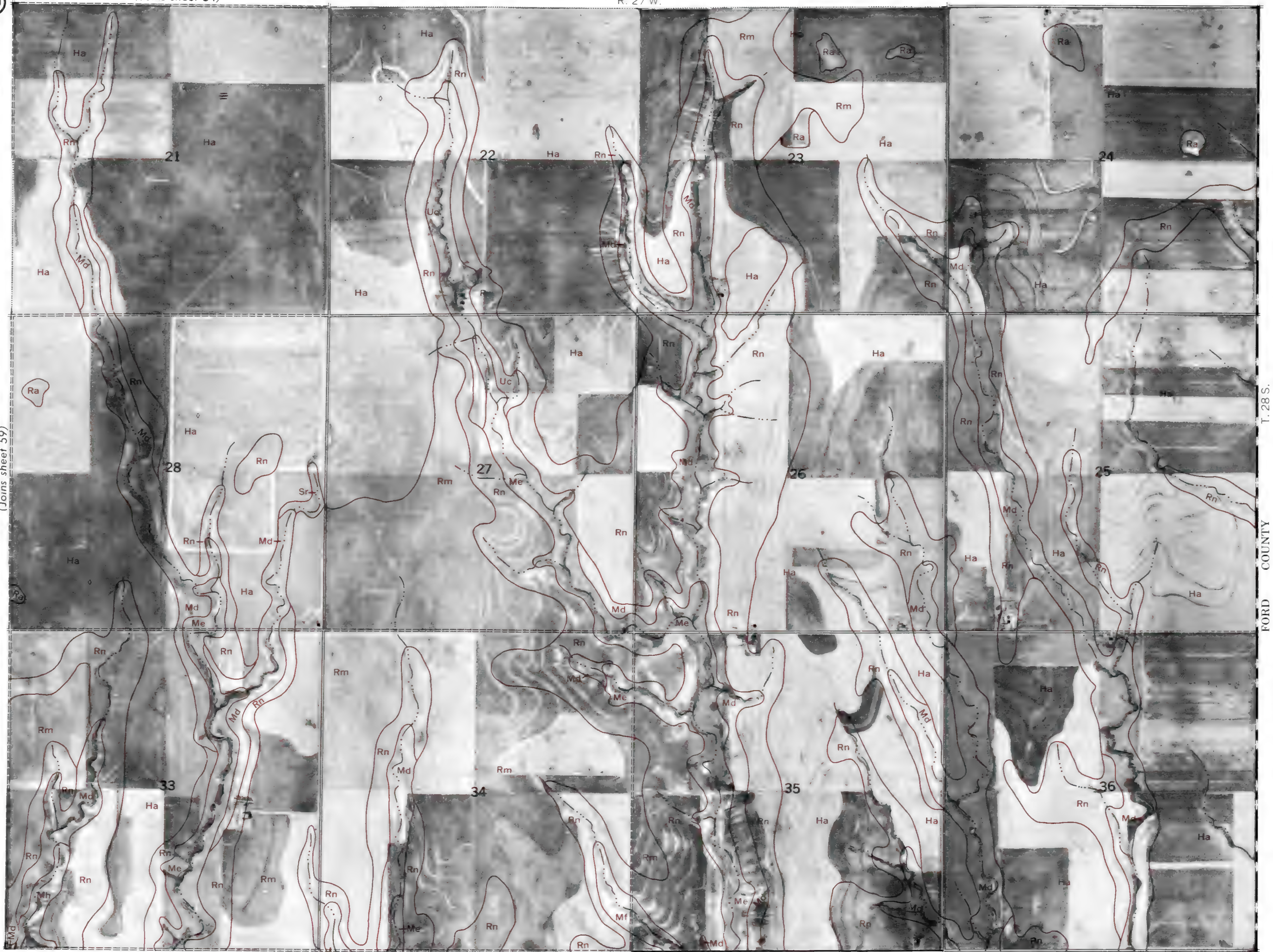
Range, township, and section corners shown on this map are indefinite



60

(Joins sheet 54)

R. 27 W.



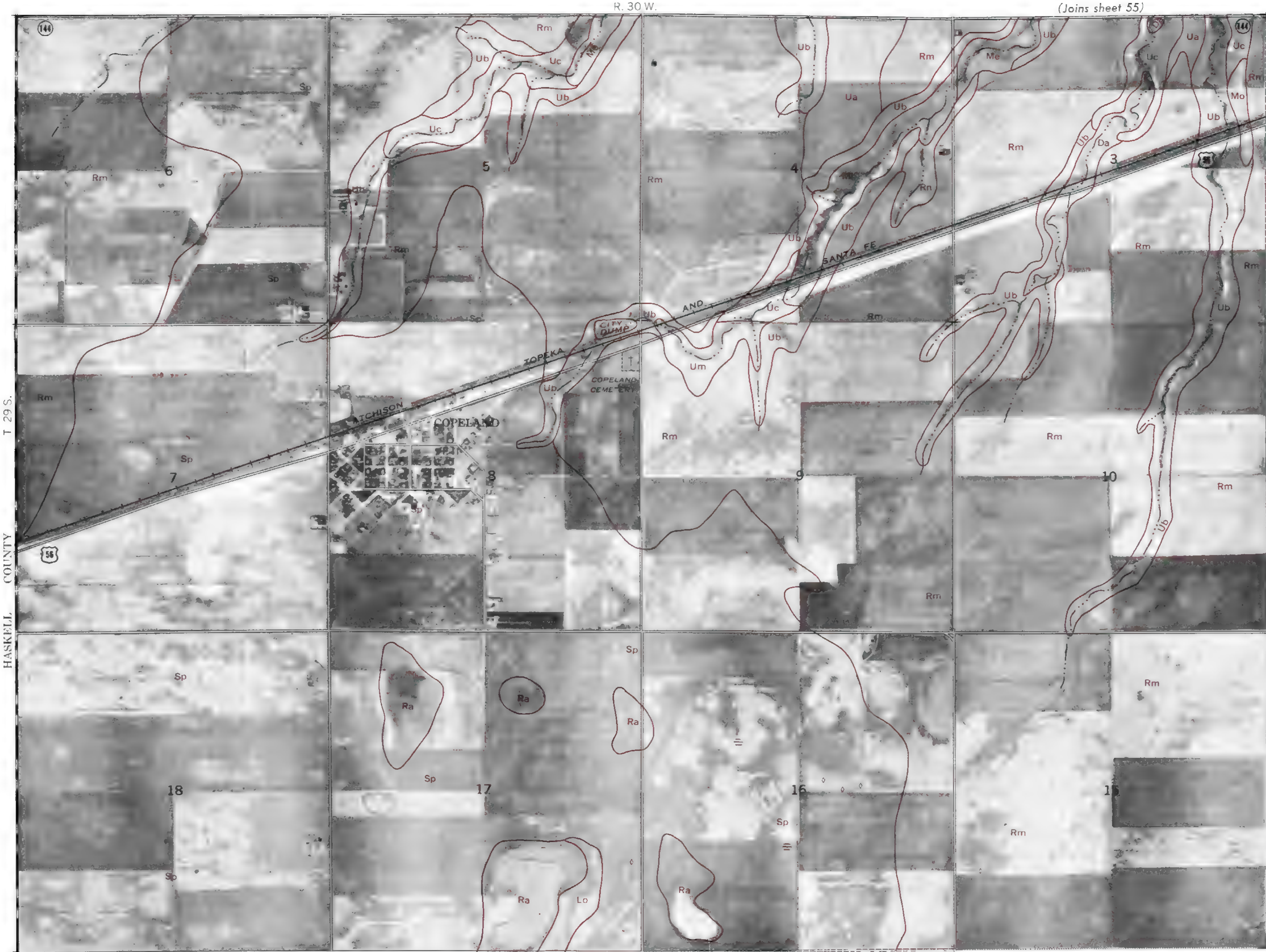

(Joins sheet 66)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 30 W.

(Joins sheet 55)

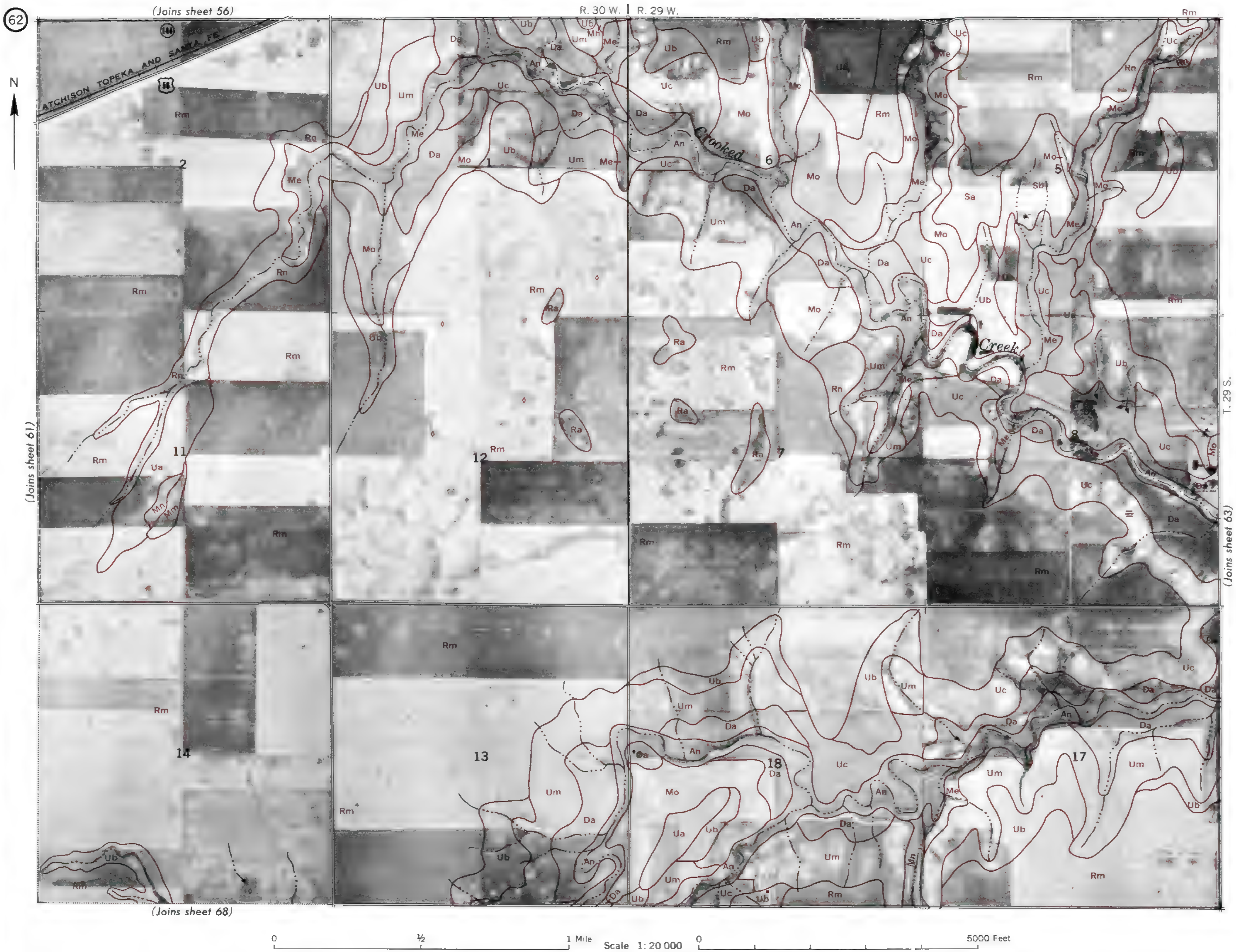
61



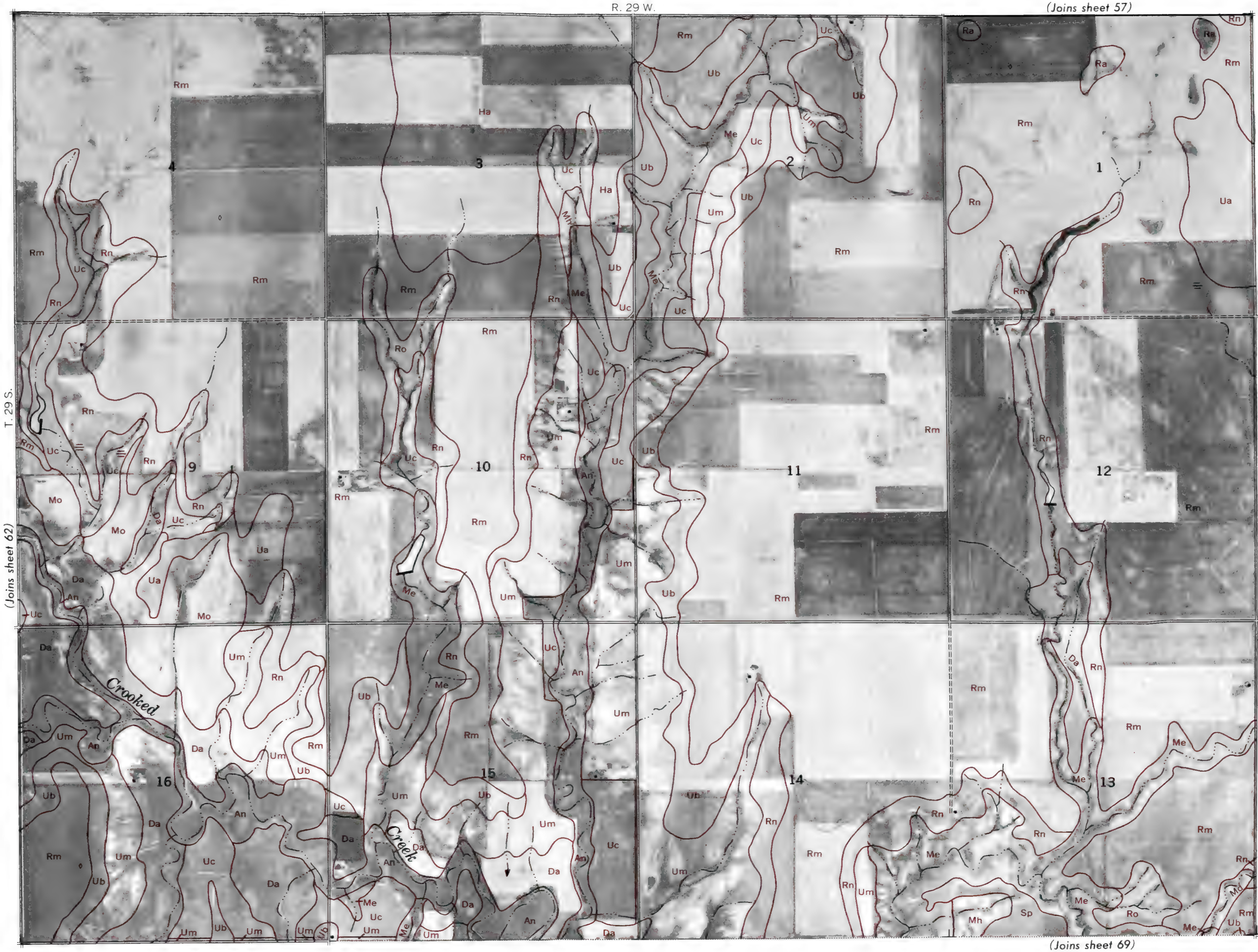

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite


62
(Joins sheet 56)
R. 30 W.
R. 29 W.
ATCHISON TOPEKA AND SANTA FE
N
Crooked
Creek
T. 29 S.
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 68)
1
2
5
6
7
8
11
12
13
14
17
18
Rm
Um
Ub
Uc
Mo
Me
Da
An
Ra
Ua
Sa
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

63

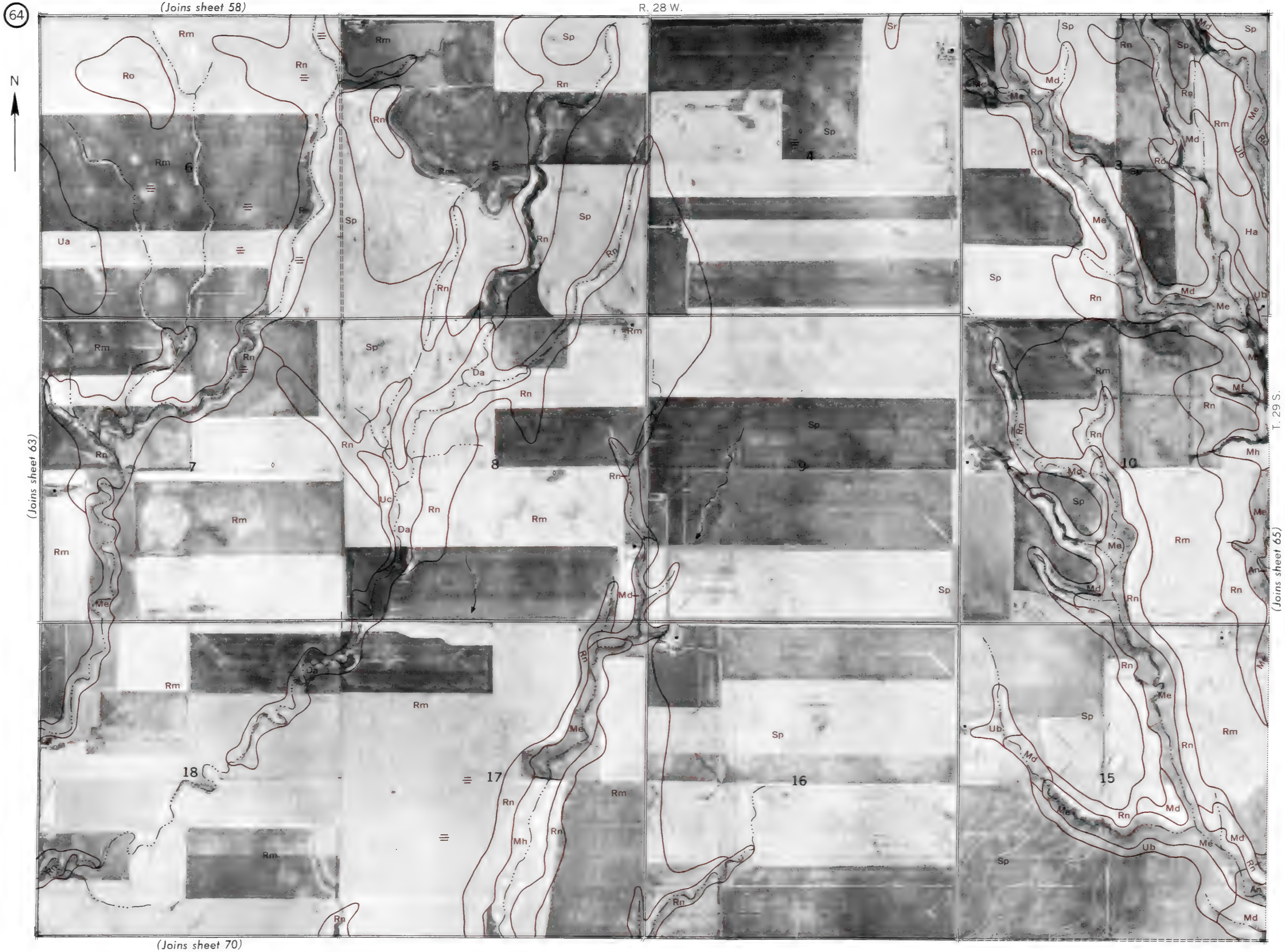



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

GRAY COUNTY, KANSAS — SHEET NUMBER 64

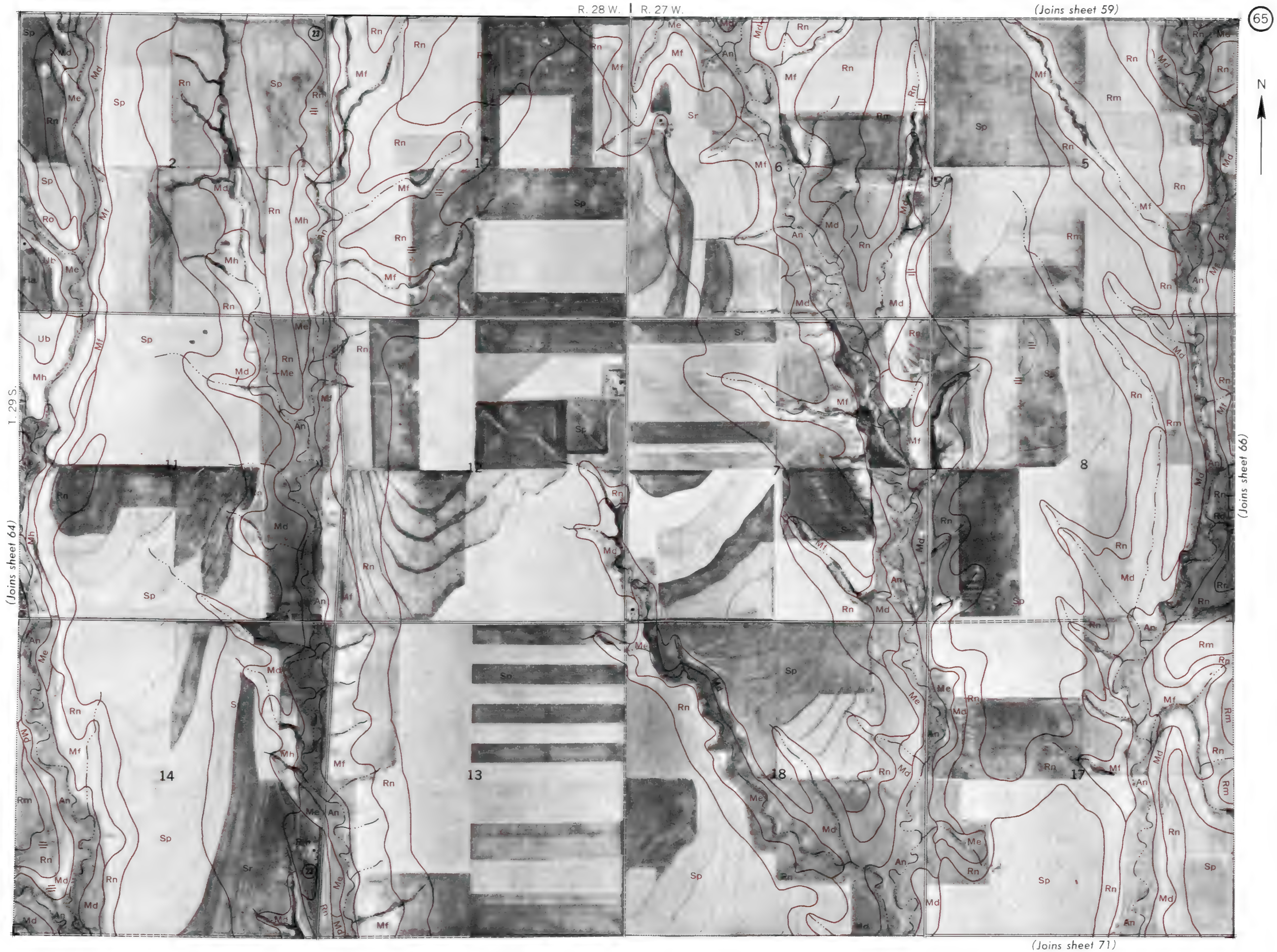



Scale 1:20 000 — 0 ½ 1 Mile — 0 5000 Feet

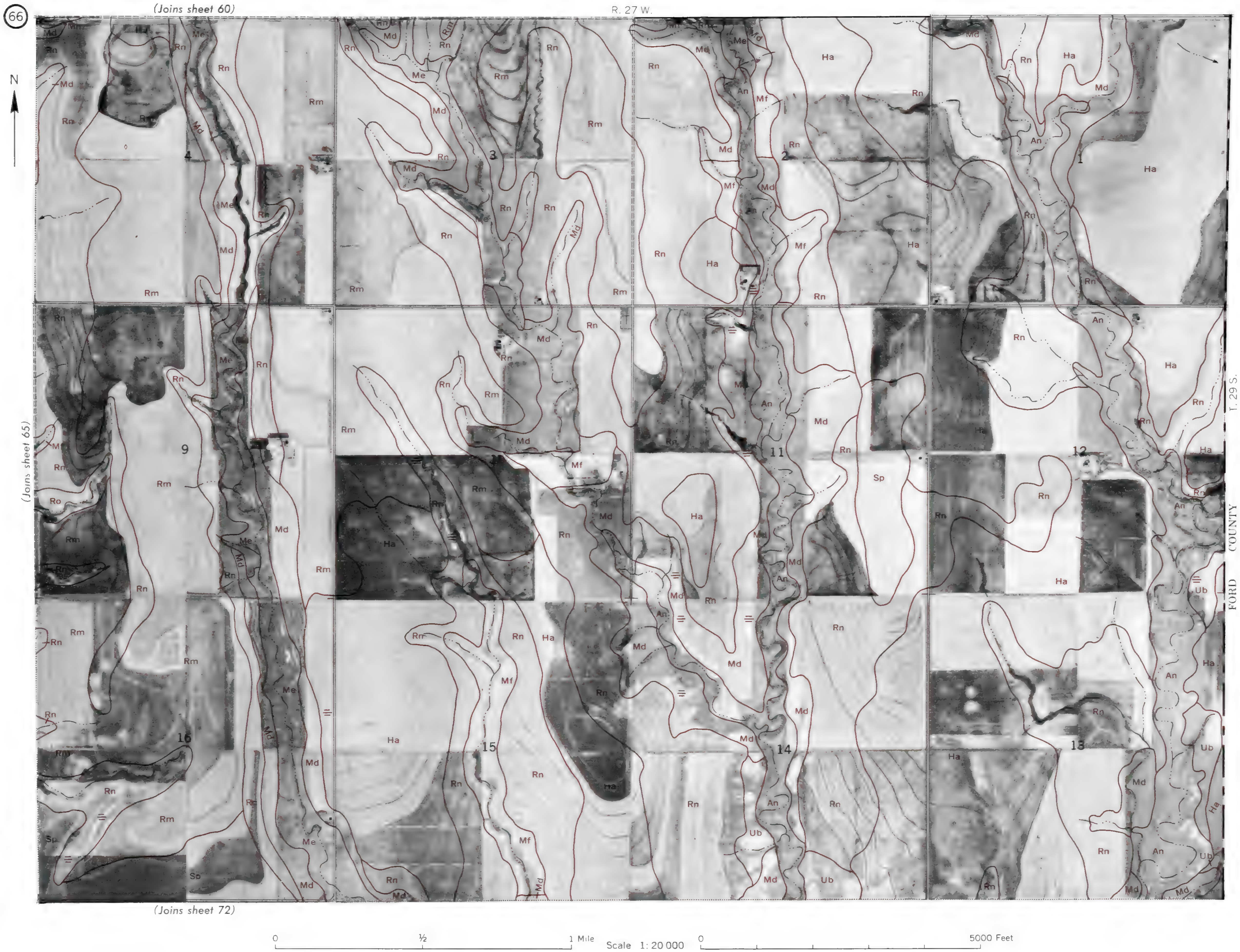
GRAY COUNTY, KANSAS — SHEET NUMBER 65

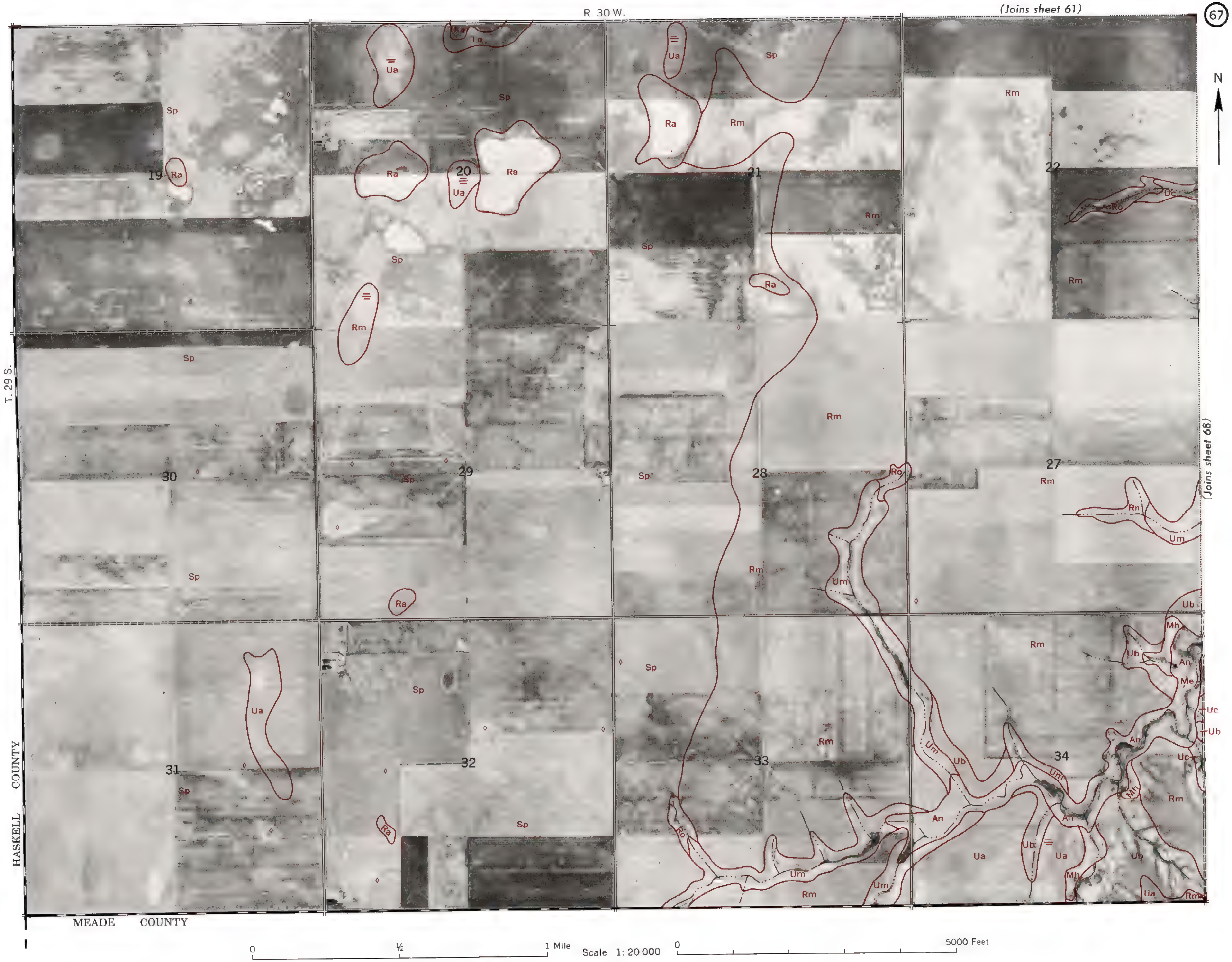
This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite



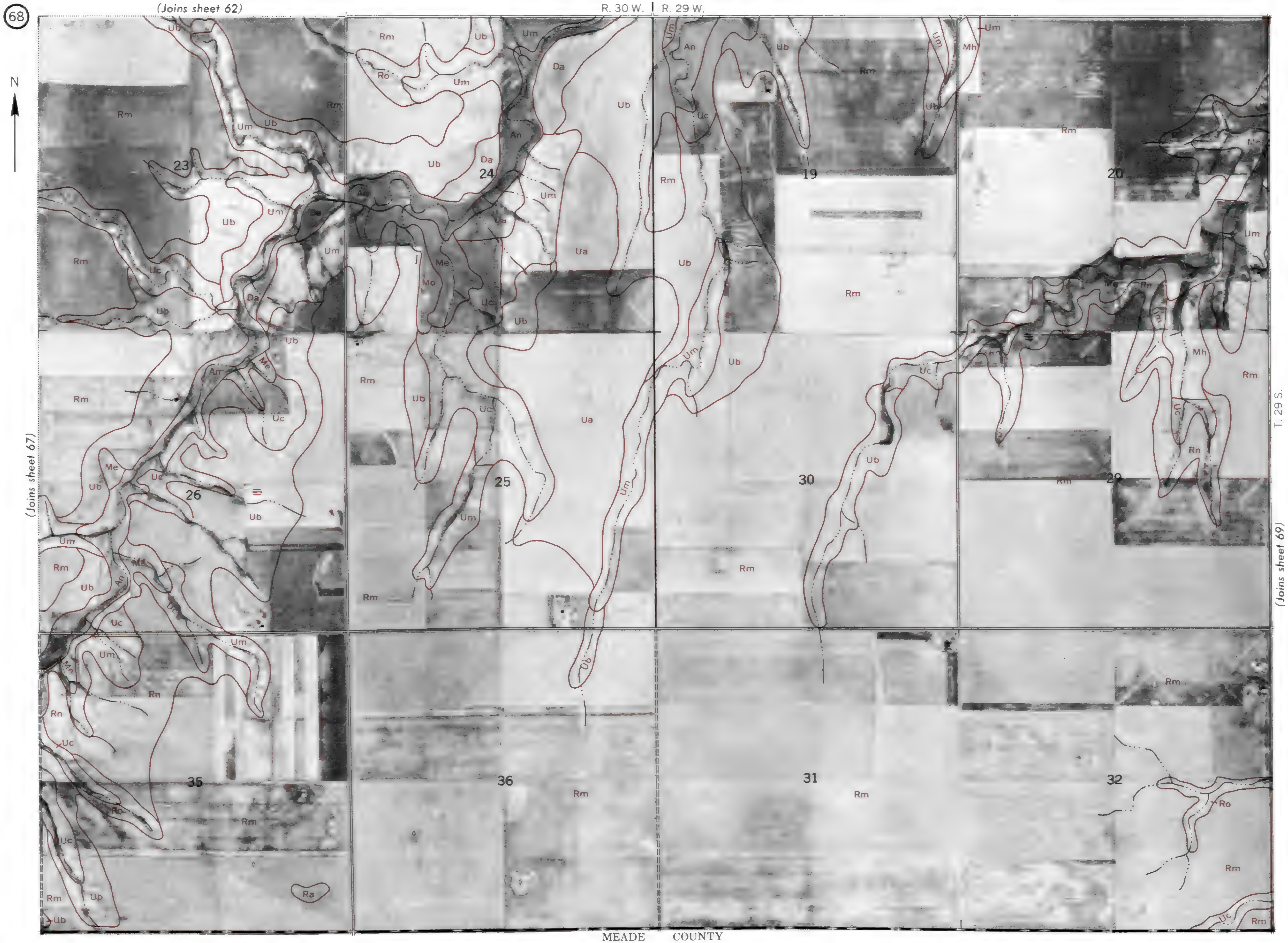

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


66
(Joins sheet 60)
R. 27 W.
N
(Joins sheet 65)
T. 29 S.
FORD COUNTY
(Joins sheet 72)
1
2
3
4
9
11
12
13
14
15
16
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

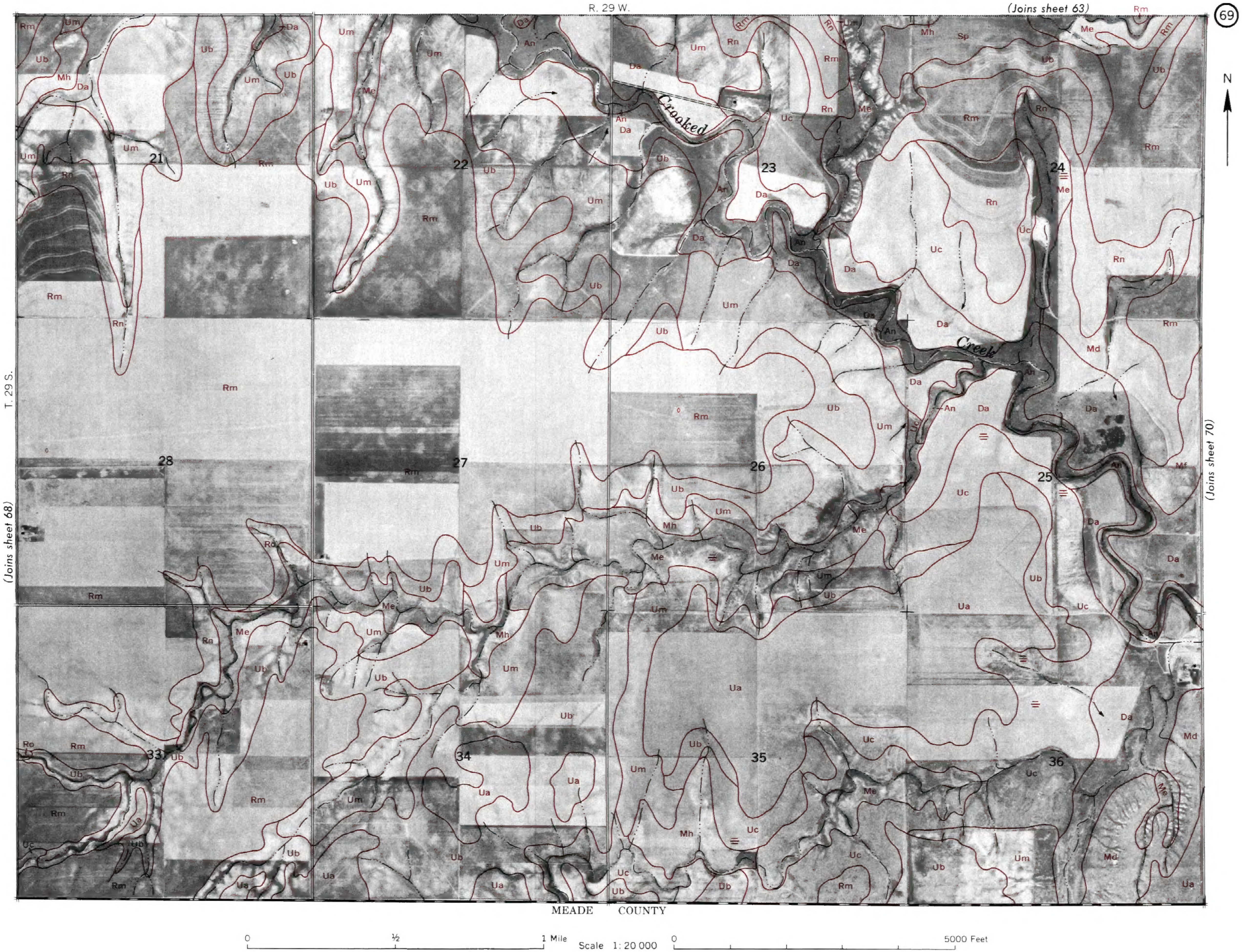



This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

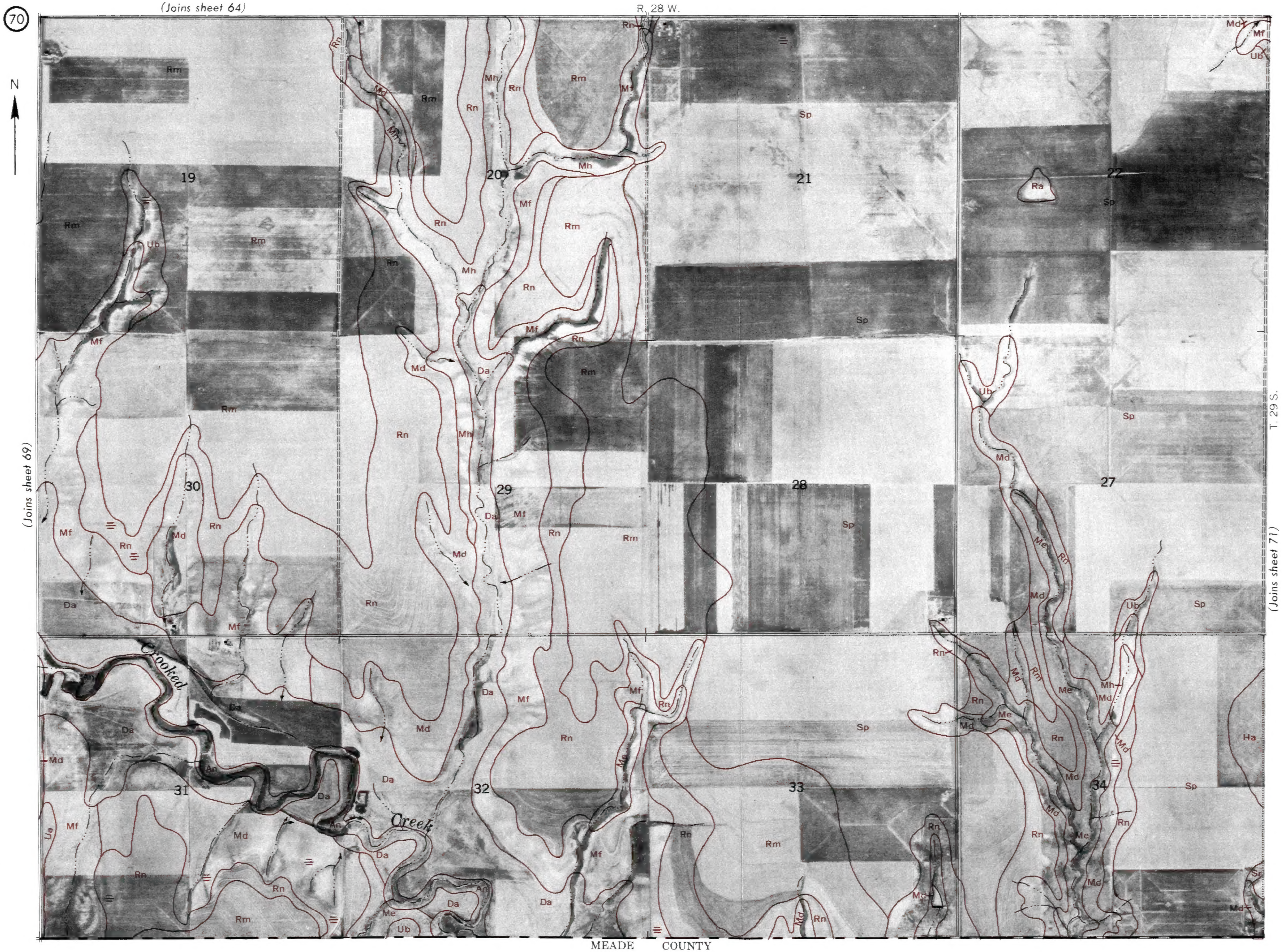



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

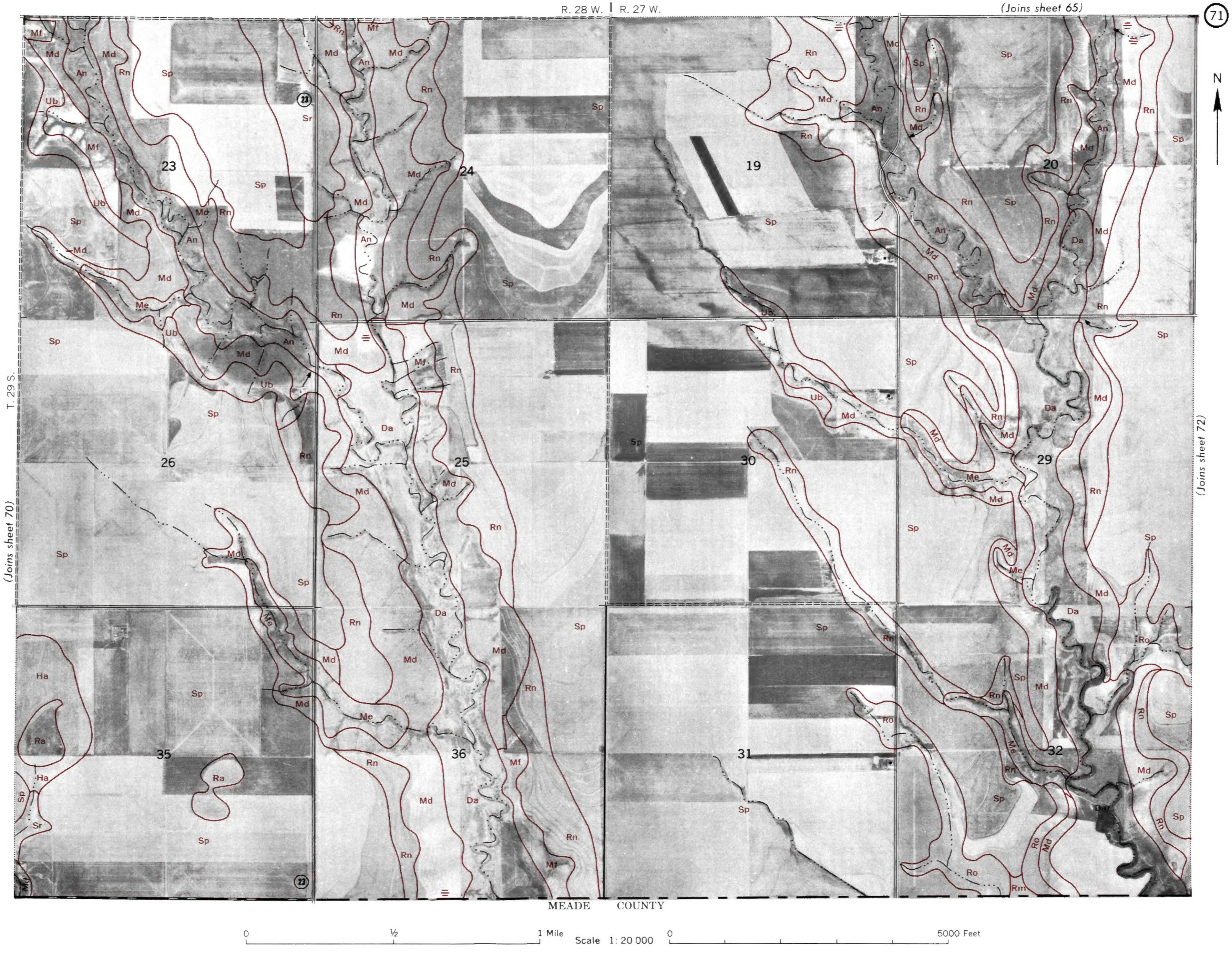



This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

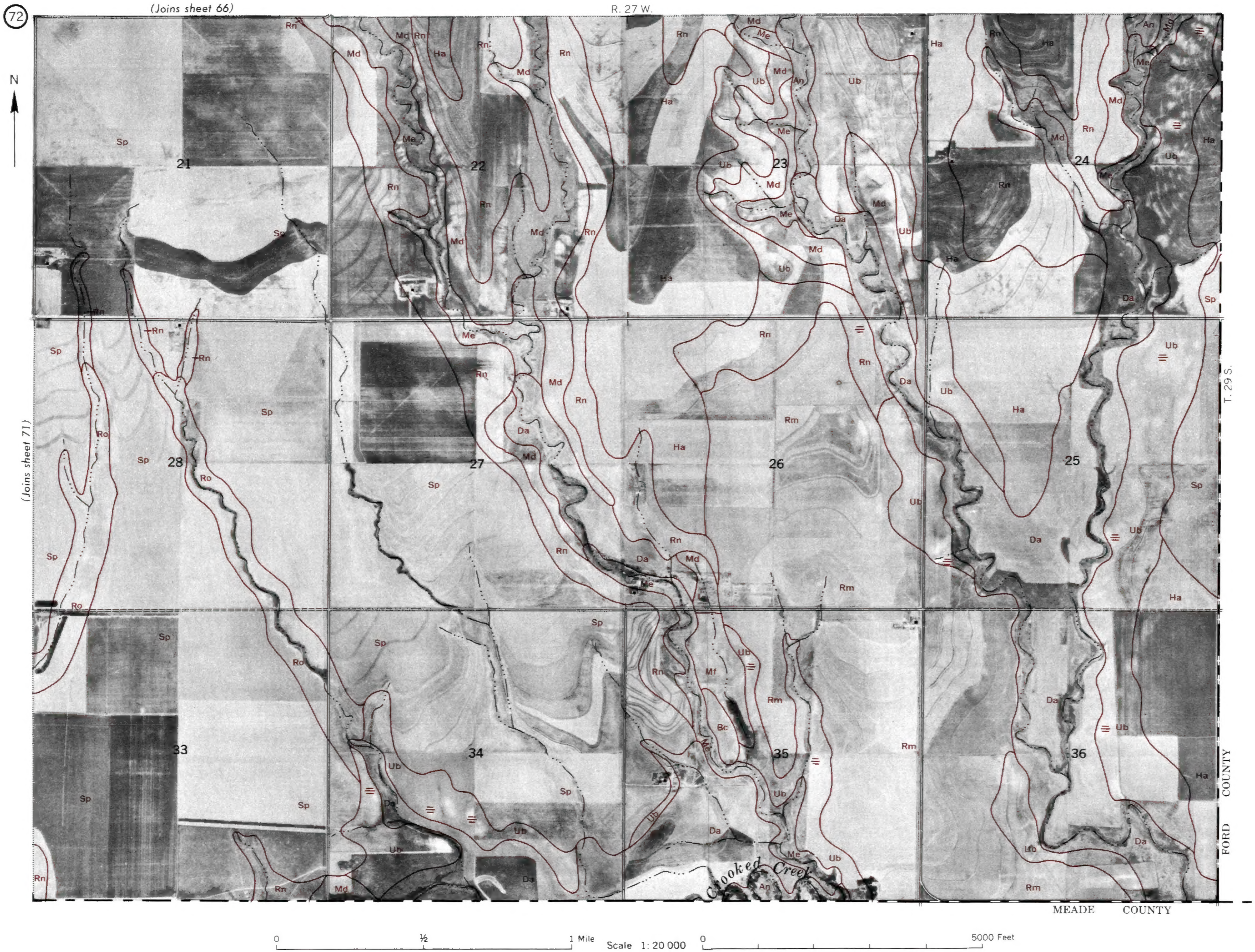



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet




This map is one of a set compiled in 1966 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


72
(Joins sheet 66)
R. 27 W.
N
(Joins sheet 71)
T. 29 S.
21
22
23
24
28
27
26
25
33
34
35
36
Crooked Creek
FORD COUNTY
MEADE COUNTY
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet